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The effectiveness of integrating ICTs in the teaching of Mechanical System and control in a Grade 8 Technology subject: A case of two township schools

By

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A thesis submitted in partial fulfilment of the requirements for the Degree of

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University of the Witwatersrand

Supervisor: Dr. Samuel Khoza

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DEDICATION

This study is dedicated to:

My late mother Nombulelo Emma Nkosi your teachings and values remain instilled in my heart and memory. May you continue to shine light in all paths I take in life. Your memory lives on in me…

ABSTRACT

Information and Communication Technology (ICT) in the education system have been highly received and thus viewed as a catalyst for change in teaching and learning practise that take place in the classroom. ICTs have been highly researched in the education systems globally and their impact in education has been phenomenal at most. This is because ICTs are introduced in schools as a means of improving educational outcomes with hope to also enhance the standard of teaching and learning. Within the education system, the assumptions is that "ICT helps in providing a catalyst for rethinking teaching practices" (Flecknoe, 2002; McCormick & Scrimshaw, 2001 cited in Noor-Ul-Amin, 2013, p.8). The research aimed at investigating how effective teaching and learning was achieved using ICTs in the subject Technology classroom, especially in teaching of a Mini-PAT in the concept of Mechanical Systems and Control. This research explored skills and competencies needed by teacher to help them integrate ICTs into their lessons and teaching and the challenges they face. The study explored how effective teaching and learning was achieved by Grade 8 Technology teachers when ICTs were integrated into their lessons, especially in the teaching of a Mini PAT in the concept of Mechanical system and control. Mishra and Koehler (2013) technology, pedagogy, and content knowledge (TPACK) were used to frame the research.

This research employed a qualitative research approach. Purposive sampling was used to select four secondary school teachers who teach Technology Grade 8. Semi- structured interviews and classroom observation were used as a means of collecting data. The research findings revealed that teacher's attitude, perceptions and beliefs shape the manner in which ICTs are integrated and utilised within the subject hence its effectiveness in practice. The study also found that policy regarding ICTs is not made transparent to teachers and stakeholders. The study concluded that the TPACK of the participants influenced and shaped effective teaching and learning practices when ICTs were integrated into their lessons, especial in the teaching of the concept of Mechanical systems and control and its Mini PAT. The study recommended; providing teacher professional development centres whereby teacher can learn to develop activities related to technology as means of enhancing

their technology skills, providing teachers support partnership that can enable them to share effective strategies for technology, matching the content uploaded onto the smartboard with the teachers' set work, school's curriculum policy and textbooks, having a technical support team that is well trained and available at schools at all times, decentralising the technical assistance and training to name but a few. Furthermore, the schools policy must be adjusted to fit ICT rules usage in class and school, to enable the teacher to use effectively ICT tools and be able to manage their classrooms and teaching using ICTs.

Keywords: Mini-Practical Assessment Task; Mechanical systems and control; Technological Pedagogical Content Knowledge, Information and Communications Technology

DECLARATION

I hereby declare that the research submitted is in partial fulfilment of the requirements for the degree of Masters in Education at the University of the Witwatersrand is my own original work. All quoted sources are indicated and acknowledged by means of a complete list of references.

Signature _____ on the 04th of October 2019

Nobuhle Nkosi

Student number: 691767

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Chapter 1: Background to the study

1.1 Introduction

The influence of computers in our lives cannot go unnoticed because technology influences and shapes every facet of our lives. It is no surprise that it has infiltrated the education system and has shifted not only teaching but also the learning practices that exist. Information and Communication Technologies (ICTs) are used as tools that aid teaching and learning, rather than creating an environment that enables learners to expand their creativity and be able to design new things. I have been fascinated by the possibilities that ICTs could offer in different subject, especially in a technical subject like Technology. The subject comprises of practical tasks rather than only being theory based. I became fascinated by the subject and wondered how teachers of such a subject teach using ICTs and how often they use ICTs in their lessons.

Because of its intricacies the term ICTs embodies different definitions according to its use and context. A definition that has been used by this study is one that is outlined by the Department of Education (DoE). The White Paper on e-Education (2004) defines and understands ICTs to represent the convergence of Information Technology (IT) and communication technology.

The reality in practice is that teachers are slowly warming up to using ICTs and are constantly undergoing training as to equip themselves with the necessary skills needed to enable them to use ICTs so as to be able to teach effectively, especially in piloted schools. It has been duly noted that the education system still operates under the guise of the past regime. However, there have been measures put in place as an attempt to redress and equalise the education system. With changes made in policy, curriculum and the teaching and learning itself, we can divulge that the educational transformation process is a sluggish, nonetheless it is a progressive one. The interest in pursuing the research emanates from the Gauteng Member of Executive Council (MEC) initiative to integrate ICTs into public schools with an aim of enhancing teaching and learning standards, and shifting classroom structures from the traditional textbooks to paperless classroom. In 2015, an initiative by the Gauteng MEC, Mr Panyaza Lesufi, which involved a roll out of tablets and smartboards into township schools, shifted the conventional learning practices of

township schools to the envisioned paperless classroom. The initiative targeted selected schools from Gauteng with the aim to pilot them by means of integrating ICTs into public and township schools, with the aim of improving teaching and learning standards in the process redressing issues related to teaching and learning practises within the schools.

With the intention to examine the manner in which ICTs are integrated into schools and their impact on teaching and learning, the study attempted to understand how effective teaching and learning was achieved using ICTs in the subject Technology classroom, especially in teaching of the Mini- Practical Assessment Task (Mini-PAT) in the concept of Mechanical Systems and Control in a Grade 8 class. The Department of Basic Education (DBE), Curriculum and Assessment Policy Statement (CAPS) document (DBE, 2011) defines and outlines (Mini-PAT) as:

A set of short practical assessment tasks which make up the main formal assessment of a learner's skills and application of knowledge during each term. It may be an assignment covering aspects of the design process, or it may be a full capability task covering all aspects of the design process (Investigate, Design, Make, Evaluate, Communicate- IDMEC). It is composed of a variety of forms of assessment suited to the range of activities that make up a Mini-PAT.

Purpose: a Mini-PAT is intended to formalise the practical component of Technology contextualised within a knowledge focus. Practical activities should make up at least 40% of a Mini-PAT's mark allocation.

- The Mini-Practical Assessment Task is designed to give learners the opportunity to develop and demonstrate their levels of ability (i.e. capability) as they progress through the task's activities.
- Each mini-PAT focuses primarily on one of the knowledge foci of Technology (viz. structures, mechanical systems and control, electrical/electronic systems and control and processing), but may be integrated and may target more than one knowledge focus. Textbook writers are expected to develop the Mini-PATs.
- These tasks are structured according to the design process:

Investigate – Design – Make – Evaluate – Communicate.

NB: This is NOT a LINEAR process happening in a fixed sequence.

- Assessment in a mini-PAT need not cover all aspects of the design process each term.
- A mini-PAT is an extended formal assessment task and must be planned with other school activities.

Mini PAT

- The Mini-PAT makes up 70% of each term's assessment. Practical work must make up more than half of the marks.

It then becomes obvious that the Mini-PAT plays an essential role within the subject. The research attempted to understand how effective teaching and learning was achieved using ICTs in the subject Technology classroom, especially in teaching of a Mini-PAT in the concept of Mechanical Systems and Control. The research also concerned itself with the different types of knowledge and competencies required by the teacher in order to be able to successfully utilise, incorporate and integrate ICTs in their lessons. The latter is unpacked in the review of literature.

1.2 Background

According to the DBE (2011), technology education was introduced into the South African curriculum as means of recognising the need for the country to produce engineers, welders and technicians as means of developing a technologically literate generation. The term technology holds numerous definitions, as it takes on different uses in different contexts, and is commonly referred to in relation to machinery and devices developed from scientific knowledge, which is in its narrow definition. In the context of education and this study, Technology in relation to a learning area or teaching subject can be defined as, "the use of knowledge, skills, values and resources to meet people's needs and wants by developing practical solutions to problems, taking social and environmental factors into consideration" (DBE, 2011, p.8).

In the intermediate phase, the subject Technology shares its time allocation with Natural science in which the two subjects coexist and the instructional time allocated

to the subject is three hours and 30 minutes weekly. In the senior phase, the subject acts as a base to provide learners with the basic understanding of knowledge of the fields related to Technology such as Civil Technology, Mechanical Technology, Electrical technology, Engineering Graphics and Design (EGD), Physical Sciences and Design. The CAPS (DBE, 2011) policy document hopes that Technology education in schools will provide learners with enough experience that will equip them with the necessary skills needed to prepare them for the world of work, based on the subjects they choices made in Grade 10. The breakdown of the subject and its potential career field is as follows:

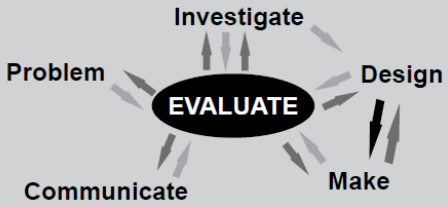
1.	**THE DESIGN PROCESS SKILLS (non-linear):** • Investigation skills • Design skills • Making skills • Evaluation skills • Communication skills 
2.	**STRUCTURES**
3.	**PROCESSING OF MATERIALS**
4.	**MECHANICAL SYSTEMS AND CONTROL**
5.	**ELECTRICAL SYSTEMS AND CONTROL**
6.	**TECHNOLOGY, SOCIETY AND THE ENVIRONMENT** • Indigenous technology • Impact of technology • Bias in technology

***Figure 1**: The breakdown of the subject, Source: DBE (2011)*

The above diagram highlights the focus areas associated with the Technology curriculum. The subject consist of four learning areas which must be done yearly, they are; Structures, Processing, Mechanical systems and control and Electrical systems and Control in which the learner engages in thought creating practical projects like Mini-PAT. The research centres its focus on investigating how effective teaching and learning is achieved, in teaching the concept of Mechanical systems and control and how the concept is taught using ICTs.

Mechanical Systems and Control

Mechanical systems and control is an area of technology that deals with mechanism and control systems. It explains and gives a clear indication on how hydraulic systems work in order to operate machines like the hydraulic press, car jacks and hydraulic lifts (Mfusi et al, 2011). Mechanical systems involve different parts that are joined together to perform a specific function. Levers and linkages are bars that are joined together to perform a task ((Mfusi et al, 2011). In real life situation, we have examples of levers which learners use daily like a pair of scissors, see-saw, knifes, spoons and fish rod.

The concept of levers and linkages help learners to master the world around them, and makes them understand that without mechanical systems and control certain jobs were not going to be successful. Hydraulics operates with compressed liquids to produce an output force. The liquid needs to be pumped from the reservoir to push the output cylinder (Mfusi et al, 2011). Learners have to understand the concept of hydraulics systems as this will help them in their design and creation of Mini PAT of Mechanical Systems and Control.

When teaching pneumatic system, the educator must be able to explain how pneumatic systems operate. Educator must be able to demonstrate how pneumatic systems work using for examples syringes or bicycle pump. In essence a pneumatic system is a branch of Mechanical System and control that deals with compressed air.

When teaching the control devices, the educator must understand how the control devices work to control different mechanisms. Examples of control devices are one-way valve on the soccer ball, the ratchet system and the cleat system ((Mfusi et al, 2011). The educator must help learners understand how the controls systems work so that they are able understand how certain mechanisms operate in real life situations.

Reforming the education system will provide teachers and learners with various learning and creative and communication skills that will allow them to participate in society and the workforce. These skills are learned in class and within the subject, and are assessed using Mini-PAT. Assessment should ideally be integrated with

planning so that teaching and learning activities are not devoid of it (Motshekga 2009 cited in Mapotse & Gumbo, 2013, p.25). The White Paper on e-Education (2004) in stipulates formal assessment requirements for Technology are as follows:

- Formal assessment for Technology will consist of the Mini-Practical Assessment Tasks (PAT) and pen and paper tests or examinations.
- At least 40 out of the 70 Mini-PAT marks per term must be attributed to Practical Work.
- Teachers should monitor tasks done by learners for formal assessment purposes at all times.
- Work done "off-campus" outside the direct control of the teacher should normally not form part of the formal assessment record.
- The end of year promotion mark will comprise 40% CASS and 60% (Mini-PAT 20% examination 40%) end of year examination:

Table 1: Formal Assessment in Technology – Grades 7, 8 and 9

	INFORMAL DAILY ASSESSMENT	FORMAL ASSESSMENT : TERM MARKS		
		Practical Tasks and Theory Test / Examination		TOTAL
	Enabling Tasks	Mini-PAT	Term Test / Examination	Term Mark
Term 1	0%	70%	30%	100%
Term 2		70%	30%	100%
Term 3		70%	30%	100%
Term 4		70 marks = 100%	No Test	100%

Promotion Mark	CASS Component: 40%	Final Examination Component: 60%		Promotion
	Continuous Assessment : Test and Mini-PATs 40	Combined Mini-PAT: 20	Examination: 40	
	Term 1 + Term 2 + Term 3 + Term 4	T1 + T2 + T3 + T4	40	100
	10 + 10 + 10 + 10	5 + 5 + 5 + 5		

***Figure 2**: Formal Assessment in Technology, Source: DBE (2011)*

The purpose of Mini PAT and its assessment is to formalise the practical aspects of the subject in by contextualising it in order for learners to fully grasp and understand the practicality of the subject. Therefore, each Mini-PAT focuses on the different knowledge structures the subject offers i.e. Structures, Mechanical Systems and Control and so forth. However the different components of the subject can be integrated to focus on more than one element to broaden the knowledge focus. Therefore the study is aimed at investigating how effective teaching and learning

was achieved using ICTs in the subject Technology classroom, especially in teaching of the concept of Mechanical Systems and Control.

In view of the CAPS (DBE, 2011) document in regards to the subject, I believe that it is worth examining the effectiveness of implementing and integrating ICTs within the subject in a township school. The challenges and succession that arise in implementation and integration should be highlighted as to make recommendations to ensure that effective teaching and learning is enhances and continues to thrive. The research foregrounds teachers' effective teaching and learning using ICTs in the subject Technology classroom, especially in teaching of the concept of Mechanical Systems and Control and its Mini-PAT. Teachers' experiences within the subject affects the manner in which ICTs are implemented and integrated in the classroom thus this has major impacts in practice. Lastly the research throws light on the burdens (if any) related to administration, classroom practice, teaching and learning and ICT integration as means of also improving the latter especial in the early stages of ICT integration.

To conclude, the study is of values as it attempts to provide a clear picture of how effective teaching and learning is when ICTs are integrated in practice, especially in teaching of the concept of Mechanical Systems and Control and its Mini-PAT by providing findings and recommendations that can be used to improve effective teaching and learning in ICT integration and teaching.

1.3 Rationale

ICTs in education are widely accepted and have received copious responses. The White Paper on e-Education (2004) outlines the different possibilities ICTs in education offer in schools and its impact in learning. It states that "e-Education is more than developing computer literacy and the skills necessary to operate various types of information and communication technologies. It is the ability to:

- apply ICT skills to access, analyse, evaluate, integrate, present and
- create knowledge and new information by adapting, applying, designing,

- function in a knowledge society by using appropriate technology and communicate information; inventing and authoring information; mastering communication and collaboration skills"(DoE, 2004, p.14).

The concepts of E-learning is one that is taking the world by storm and showing shift in the teaching and learning practices as they previously existed. It encompasses re-evaluating teaching and learning practices that were formally informed by the outcome based education by means of introducing and integrating ICTs in education as a means of creating a new learning environment and practices. Enriching the learning environment with ICTs is a continuum. It is a process that takes learners and teachers through learning about ICTs (exploring what can be done with ICTs), and learning with ICTs (using ICTs as means of supporting the new teaching and learning practices), and enriching each other at the same time (DoE, 2004, p.14, 19).

According to Ertmer (2006), ICTs can only function as a relevant pedagogical tool if: (1) teachers have convenient access; (2) are adequately prepared; (3) have some freedom in the curriculum; and (4) hold personal beliefs aligned with technology. Teacher training and development then becomes essential in the integration and implementation of ICTs in education, as the latter will influence the manner and level in which the teacher will be able to use ICTs in class. Ertmer (2006) further argues that teachers will respond to technological integration based on existing educational beliefs and experiences. Given that teachers have different beliefs in relation to methodology and pedagogy, their beliefs and attitudes towards the use of ICTs and implementation will differ. Furthermore, Ertmer (2006) suggests that teachers should be met at their point of need where their confidence in the use of both the new pedagogy and technology should be bolstered through a "Gestalt shift" where "small successful instructional changes' are made before challenging larger ones. In essence, teachers believes about ICTs in education will impact and influence the manner in which ICTs are used and not used in their lessons.

The study emanates from the interest in Technology as a teaching and learning subject and the opportunities ICTs could bring to enhance teaching and learning whilst aiding challenges within the subject; especially in the teaching of the concept of Mechanical systems and Control and its' Mini-PAT.

The Mini-PAT as previously highlighted is a peer assessment tool that teachers use as a form of multi-source feedback assessment. It provides learners with feedback based on their individual performance; skills, attitude and behaviour, which they can use as a reflection on the projects, that they have completed as means of demonstrating their levels of ability. Therefore, Mini-PAT reinforces the Design principles which will allow the learner the opportunity to develop their design and making skills. Within the subject, Mini-PAT serves as the main formal assessment to test learners' skills and application of knowledge. For this research Mini-PAT is essential in evaluating how Mechanical systems and control are taught and assessed, hence the contribution of this research. Therefore, the rationale of this study is to investigate the effectiveness of teaching and learning when ICTs are integrated into the subject Technology classroom, especially in teaching of the concept of Mechanical Systems and Control and its Mini-PAT. Challenges that arise during integration in the two piloted schools were also highlighted.

1.4 Significance of the study

Schools can be seen as prominent factors that drive social institutions and have the potential to transform individuals lives based on the social contexts in which they live, by providing them with the necessary skill to better and free themselves from the material condition that they may exist. With that in mind, it is important to note that Education and the Information Society in the global scale brings about complex debates related to schooling whereby education is set to open up terrains in which educational technology is forced to respond to new challenges instead of addressing existing ones. The White Paper on e-Education (2004) outlines that:

The ICT revolution has had an impact on curriculum development and delivery and continues to possess new challenges for education and training systems around the world. These challenges can be summarised into three broad areas, namely:

- participation in the information society;
- impact of ICTs on access, cost effectiveness and quality of education; and
- integration of ICTs into the learning and teaching process

The paperless education system has received ambiguous responses, with some teachers still reluctant to use ICTs in their lessons, as some teachers still fear using ICTs while others view it as a distraction while some fear that ICTs will replace them and others simply cannot utilise the gadgets. Some teachers on the other hand are open minded and have seen ICTs as tools that aid learning and has the potential to afford learners access to learning material, workbooks and other subject matter that the teacher cannot offer in the conventional classroom through the use of ICT. The latter will enable both the teacher and learners to compete and participate in the sharing and creation of teaching and learning material locally and globally. However, the South African schooling system itself manifests and perpetuates unequal opportunities in terms of access and quality of education. Therefore, the significance of this study is to highlight how effective of teaching and learning was achieved when ICTs are integrated into the subject Technology classroom, especially in teaching of the concept of Mechanical Systems and Control and its Mini-PAT. This is so because Mechanical Systems and control as a concept, is the crux of Technology subject which aims at assisting learners for career choices.

1.5 Problem statement

As much as the education system has progressed, there are many challenges that the South African township and public school education system still face. The challenges range from under resourced schools, issues of access to quality education to name but a few. Currently, higher education in South Africa is under increasing pressure to meet the social transformation and skills needs of the new South Africa (Kistan, 2002 cited in Jaffer, Ng'ambi, & Czerniewicz, 2007, p.132). The harsh realities remain that even though the schooling system has envisaged a global learning environment whereby ICTs are a driving force, most of the South African education classrooms are still text-based. As mentioned previously township and public school teachers still face a number of challenges including overcrowded classrooms whereby the teacher-learner ratio ranges from having 45 to 60 learners per class. This is despite the infrastructural and shortage of resources including textbooks that the teachers face daily. It is discernible that the government’s promise to provide education for all is a plausible, as most schools still face such challenges.

According to the DBE (2011), the teaching time for Technology is two (2) hours per week. As this subject involves practical work, 60 minutes of the two hours should be one continuous period for practical work, e.g. one double period comprising two periods of 30 minutes. In the subject like Technology, teachers face difficulties with periods for syllabus completions. This is mainly because the hours that are allocated to the subject make it almost impossible to cover the content required because learner's move at different paces. The time allocated to the subject also makes it hard for teachers to give individualised attention to learners and makes it even harder for teachers to comply or meet syllabus completion on time.

The study acknowledges the role ICTs play in attempting to reshape the education system but they won't be effective if teachers are not using them appropriately. Therefore teacher's competencies in using and integrating ICTs are crucial in determining the effectiveness of ICTs in the classroom and how they impact teaching and learning. Presently ICTs are attempting to become a driving force in the country's education system, as the county's education is still trying to redress inequalities of the past regime. In an attempt to redress these inequalities, ICTs are being implemented in some of the schools hence the researches interest in pilot schools.

The Department of Education (2007) acknowledges that the implementation of E-education in schools has the potential to offer the education system greater opportunities that could enable equal access to learning, redress inequalities that previously existed within the education and curriculum and improve the quality of teaching and learning. In so doing teachers are required to poses the necessary "knowledge, skills, values and attitudes, as well as the necessary support, to integrate ICT into teaching and learning, and to support them in their various roles as mediators of learning, interpreters and designers of learning programmes, leaders, administrators, scholars, assessors and subject specialists" (DoE, 2007).

The study highlights complexities that are involved in the implementation and integration of digital technology in the classroom thus illustrating how the use of ICTs in schools shaped and depended on teachers competencies. The White Paper on e-Education (2007) provides a framework that teacher can use to development their ICT skills and competencies. Any framework presented in schools concerning ICT

integration and usage should be made transparent and clear and be able to provide teachers with “an understanding of the interrelationship between different components” and variables involved in integration DoE (2007).

ICT integration is about having the “appropriate selection, use, mix, fusion and integration of many sets of competencies including, but not exclusively, those in pedagogy and technology" (Information and Communication Technology in Education, UNESCO; 2003 cited in the DoE, 2007, p.4). Teachers are required to be able to use and integrate ICTs in their lessons using different repertoires. The focus of the framework is to provide an educational context for the successful development of ICT skills in an attempt to integrate ICTs successfully and harness its benefits. Integration of ICTs remains a challenge in the subject as teachers are not qualified to teach the subject and thus at times cannot perform certain task using ICTs as they are not knowledgeable in performing and executing the tasks. For example, pre-service technology teachers are trained to design different draws and represent them different on paper. Therefore the main aim of this study was to investigate how effective of teaching and learning was achieved when ICTs are integrated into the subject Technology classroom, especially in teaching of the concept of Mechanical Systems and Control and its Mini-PAT. The challenges that teachers faced in integrating and implementing ICTs in their lessons was also looked into.

1.6 Research question

This research centres on the use of ICTs and its compatibility in a subject Technology particularly in the teaching of Mini PAT in Mechanical system and control concept.

1.6.1 Main research question

What difficulties do teachers have in implementing ICTs in the teaching of a Mini PAT in Mechanical Systems and Control concept in a Grade 8 Technology class?

1.6.2 Sub research questions

- How are ICTs integrated in a technical Technology subject?
- What are the gaps that exist in integrating ICTs into teaching Mini PAT in Mechanical System and control concept?
- How can ICTs be of significance in the preparation and delivery of a Mechanical system and control Mini PAT?
- What strategies do teachers use to enable effective teaching and learning using ICTs in the subject?

1.7 Theoretical Framework

A theoretical framework that the study has adopted is a framework, which is an adaption of Shulmans Pedagogical Content Knowledge (PCK), called Technological Pedagogical Content Knowledge (TPACK). Technological Pedagogical Content Knowledge (TPACK) was introduced to the educational research field as a theoretical framework for understanding teacher knowledge required for effective technology integration (Mishra & Koehler, 2006 cited in Mishra, Koehler and Shin, 2009, p.123). The TPACK framework that can be used as guide-to-guide teachers to successfully integrate technology into teaching processes. As previously highlighted in the diagram, the TPACK framework comprises of areas of knowledge that include multiple disciplines and that the teacher must able to utilise concretely in different situations that they teach as means of effectively integrating ICTs.

1.8 Research Design and Method

The design of a research plays an important role in shaping the researchers research as it often acts as blueprint that outlines the procedures that the researcher will be undertaking when conducting their research as means of investigating and providing answers to the research problem. Research design refers to the schema or plan that constitutes the entire research study (Scott & Morrison, 2006, P.58). Scott & Morrison (2006) further add that the research design “includes a summary of the intended research topic and distinguishes between the research problem and the

research questions that are derived from the problem". The latter will assist the researcher with answers to the problem that they wish addressed. The study employed qualitative research approach as means of providing answers to the research questions posed.

According to Marshall, & Rossman (2011) a qualitative approach is one in which the investigative enquires often makes knowledge claims based primarily on constructivist perspectives (i.e., the multiple meanings of individual experiences, meanings socially and historically constructed, with the intent of developing a theory or pattern) or advocacy /participatory perspectives (i.e., political, issue related, collaborative or chance oriented) or both. Therefore qualitative research sought to understand and interpret "the meaning of phenomenon from the views of the participants" and how they understand the world around them. The study chose the qualitative research approach in order to obtain an in-depth understanding and knowledge of how teachers integrate and implement ICTs in a Grade 8 Technology classroom. Issues related to challenges faced by teachers during integration were also explored.

It is important to keep in mind that "one of the key elements of collecting data is to observe participants behaviours by participating in their activities" (Marshall, & Rossman, 2014, p.21). Furthermore, qualitative enquiry is often viewed as "a study focusing on individual lived experiences typically relies on an in-depth interview strategy" (Marshall, & Rossman, 2014, p.91). Therefore the study employed a qualitative research approach which engages in "participatory knowledge claims, narrative design, and open-ended interviewing" (Marshall, & Rossman, 2014, p.21). Qualitative approach allowed the researcher to be creative as methods employed in the approach was flexible making it easier for the researcher to interact better with the participants. They allow more creative, literary-style writing, a form that individuals may like to use (Marshall, & Rossman, 2014, p.21). The research design was discussed in detail in chapter 3.

1.8.1 Population and sampling

The data collections steps include setting the boundaries for the study, collecting information through unstructured (semi-structured) observations and observations and interviews, documents, and visual material, as well as establishing the protocol for recording information (Creswell, 2003, p.185). This enabled the researcher to use methods that helped the researcher to obtain enriching information which was generated during the study as to help them understand phenomena explored.

1.8.1.1 Population

Gorard (2001) defines population as the group one wishes to study. Creswell (2003) acknowledges that the idea behind qualitative research, in regards to population, includes purposefully selecting sites and population that is empirical for the study and can help the researcher in understanding and addressing the research phenomenon. Qualitative research allows the researcher to conduct research in sites of interest and as long as “they do not disturb the site any more than is necessary” (Creswell, 2003, p.181) as the participants involved in the study are teachers within the school setting. The researcher then needs to make sure that they “build rapport and credibility with the individuals in the study” (Creswell, 2003, p.181). Furthermore, purposive sampling was to select four secondary school teachers who teach Technology Grade 8. The study focused on two township schools whereby four teachers were purposively selected to be part of the study. Two teachers from each school were selected because they had knowledge and information that can add value to the research and help the researcher in answering the research problem and questions. The schools that were selected can be located within township areas within the Ekurhuleni North region in which learners and teachers represent two race groups (black and coloured) in South Africa. Some of the schools infrastructure was improved to better accommodate ICTs in the school.

1.8.1.2 Sampling

The researcher understands that the sample chosen plays an important part in describing the research plan set out. Sampling refers to the “activities involved in selecting a subset of persons or things from a larger population” (Scott and Morrison, 2006, p.219). The purpose of sampling is to use a relatively small number of cases to find out about a much larger number (Gorard, 2001). Furthermore, the “methods used to select the sample will determine the nature and validity of the findings that are generated from the study of that sample” (Scott and Morrison, 2006, p.219) and these influenced and shaped the purpose of the research. Purposive sampling was used to select four secondary school teachers who teach Technology Grade 8. The study purposively selected four teachers from two schools (two teachers from each school) during sampling.

1.9 Data analysis and collection techniques

Creswell (2003) asserts that data analysis involves preparing the data for analysis, conducting different analysis, moving deeper and deeper into understanding the data, representing the data, and making an interpretation of the larger meaning of the data. The researcher needs to be able to interpret and make sense of the data that they have collected using instruments that will help them analyse the data. Failure to identify and use the appropriate instrument for the collection of data, could negatively impact the findings generated by the research. The study focused on a sample of two pilot high schools within the Gauteng province. The data was collected using classroom observation and semi structured interviews with Grade 8 Technology teachers in an attempt to understand the effectiveness of ICTs in the teaching and learning of Mini PAT in Mechanical systems and control concept.

1.9.1 Observations

Observation is central to qualitative research (Marshall, & Rossman, 2014, p.139). Since “observations entails the systematic noting and recording of events, behaviours and artifacts (objects) in the social setting” (Marshall, & Rossman, 2014,

p.139). Classroom observations were central to this study as they enabled the researcher to confirm teachers' responses from the interview and match them with what happened in the classroom in practice. During classroom observations, the researcher recorded field notes that provided "concrete descriptions of what has been observed" (Marshall, & Rossman, 2014, p.139).

1.9.2 Interviews

As much as qualitative research relies on observations, it also relies quite extensively on interviews. Kvale (1996) describes qualitative interviews as "a construction site of knowledge" (p.2), were two (or more) individuals discuss a "theme of mutual interest" (Kvale & Brinkmann, 2009, p.2 cited in (Marshall, & Rossman, 2014, p.142). The research interviews of this study focused on issues related to interviewees' views on teacher training, competencies and ICT skills development; experiences and competencies of teaching the subject and ICT integration and teachers' pedagogies. The study made use of standardised (open-ended) interviews, which enabled the researcher to formulate and ask questions "that are more carefully "scripted", asking specific questions in a specific sequence, sometimes without a follow up" (Marshall, & Rossman, 2014, p.144).

1.10 Scope and delimitation of the study

This research aimed at providing insights into Technology teacher's experiences in integrating ICTs into their classrooms and lessons, especially in the teaching of concepts a Mini PAT in Mechanical Systems and Control topic. The research highlights teacher's attitudes, challenges and competencies in integrating ICTs into their classrooms and curriculum. Since it remains that the pilot schools, were the schools that were using ICTs the most in their teaching and learning, the study viewed two different schools to get a sense of pedagogical competencies and ICT readiness that the schools had. This study was conducted amongst four teachers in Tembisa, Gauteng. The researcher chose these schools because they were in close approximation to the researches residential area. The researcher chose this sample as means of getting an insight on how teachers of a technical and practical subject

like Technology integrated ICTs into their teaching thus maintaining effective teaching and learning.

1.11 Limitation of the study

Limitation that the study came across was that it was confined only to two pilot high schools. This was mainly due to time and monetary constrains. It is important that readers note that the study is not a representative of all township schools across the nine provinces, nor is it a representative of all pilot township schools within the Gauteng province. The research does not represent nor reflect teaching and learning practices within the selected township pilot schools, it was done within two schools situated in different parts of Tembisa in the Gauteng province only. Therefore findings from this study cannot be generalised to the piloted township schools across South Africa. CAPS is still regarded as a relatively new policy despite it being in practice from 2012. There is however limited literature surrounding the subject. The researcher also feels that the participants of this study may not have been completely honest in their responses and this may impact the investigations conducted within the study.

1.12 CONCLUSION

This chapter outlined the introduction, background, rationale, significance of the study, the problem statement, research question, theoretical framework, research design and method, population and sampling, scope and delimitation of the study and limitation of the study. In Chapter 2 the research focused on the review of literature where the introduction, aims of ICTs in relation to curriculum development, features of Mechanical Systems and Control, the TPACK framework and conclusions were presented and discussed.

Chapter Two: Literature Review outlining the academic debates surrounding the study

2.1 Introduction

The previous chapter dealt with the introduction, the background of the study, problem statement, as well as research questions. This chapter presents the literary review of what authors said on issues of teaching and learning with technology as well as the theoretical framework that underpins the study. Mishra and Koehler's Technological Pedagogical Content Knowledge (TPACK) framework was used and discussed in this study. This chapter aims to present a review of literature and conceptual framework that is germane to the purpose of the study. The literature focuses firstly, in the curriculum development in the education system as curriculum is viewed as the pillar of education system and a drive of a learning area. The world has changed from 1994 and these changes affect curricular and thus it is subjected to update to meet the needs of society, therefore this study looked at the role of ICTs in education. Secondly, the study reviewed literature related to the teaching of Mechanical Systems and Control and TPACK was reviewed as a means of investigating the effectiveness of integrating ICTs in the teaching of the subjected especially in the teaching of the concept Mechanical Systems and control. TPACK was used as a lens that uncovers the knowledge by teachers; firstly in their teaching of Mechanical Systems and Control and secondly, the knowledge of using ICTs that the teacher needs to exude in order to be able to integrate them in their lessons. Teacher's knowledge of the subject influences the manner in which they teach Mechanical Systems and control and impacts the manner in which ICTs are to be integrated into their teaching.

2.2 Introduction of Information and Communication Technology (ICTs) in schools

Learning through the use of ICTs is not only about creating interesting tasks for learners, the aim is help both the teacher and the learner to deepen their understanding and knowledge of what is to be learned whilst improving the standard of teaching and learning. This requires the use of higher-order thinking skills and

taking learners beyond recall, recognition and reproduction of information to evaluation, analysis, synthesis and production of arguments, ideas and performance. There is a wide consensus between researchers and scholars that Technology teachers, who are considered to be effective, are teachers that have a unique knowledge and understanding of their subject as they are able to influence the thinking and ideology within the subject. However, there is limited research around the field of technology as a learning area as there have not been developments within the subject since it was implemented.

The initial goal of the South African Education government which envisioned the first failed attempts to integrate ICTs into the education system was that:

> *Every South African manager, teacher and learner in the General and Further Education and Training (GFET) bands will be ICT capable (that is, use ICTs confidently and creatively to help develop the skills and knowledge they need as lifelong learners to achieve personal goals and to be full participants in the global community) by 2013 (DoE, 2004, p.17).*

It is worth mentioning that the failed attempts from the previous e-Education initiatives, “Gauteng online” and “Khanya”, gave rise to the current initiative on paperless classrooms. A lot has been done in improving errors that lead to failure in the first initiatives, such as providing teacher training timelessly and equipping teachers with the necessary skills for effective use of ICTs; having trainers available at schools and ICT centres available I assisting the teacher to be ICT ready and savvy, to name a few. It also helps that pre-service teachers are learning with various ICTs at university and collage so as to familiarise themselves with ICTs when they obtain their qualifications.

The government faces numerous issues relating to education and has succumbed to pressure in addressing social issues and educational transformation, De Clercq adds that “at the same time it is under immense external and internal pressure to improve on its policy and delivery performance” (De Clercq, 2002 cited in Jaffer, Ng'ambi, & Czerniewicz, 2007, p.132). The White Paper on e-Education (2004) states that the policy intention is not just to build technical skills, but also to use ICTs to extend and enrich educational experiences across the curriculum. The White Paper on e-Education attempted to realise the goal In order to be able “to build a digital and

information literacy" in practice, teacher and learners need to be "confident and competent in using technology" in order to be able "to contribute to an innovative and developing South African society" (DoE, 2004, p.15). This is to enable both the teacher and learners not only to be competent but also to be confident to use ICTs in a manner that can develop and expand their knowledge. From the latter, it is clear that being ICT literate is becoming a crucial aspect in education. However, challenges still arise as there are teachers that still feel that ICTs will replace them, therefore the government needs to ensure that that will not be the case and implement training and support that will make teachers with such perceptions to get over them. Therefore, ICTs in education are seen as a bridging factor to realising this and more.

In the South Africa context, ICTs were introduced in school as remedies to redress the unequal education system left by the past regime, as an attempt to equalise the education system. However, due to the failure of the initiatives, (mainly due to the manner in which ICTs were implemented and integrated into school) the goal was not met because teachers were not able to use the ICTs and had not being trained extensively to teach using the tools thus computers collected dust in schools and were not used as anticipated. Teachers' perception and attitudes also added to the many reasons why the vision failed. With the Paperless classroom initiative, the unintended consequence of using ICTs is that they add to and create the digital divide. Therefore, ICTs and globalisation also play an important factor in perpetuating educational inequalities thus broadening the gap between the rich and the poor. Contradictory to the latter, "ICTs embrace inclusive education by providing opportunities, alternative methods of instruction and flexible assessments for learners who experience barriers to learning" (DoE, 2004, p.17). ICTs in education have been widely embraced not because they aim to improve the quality of education. They also that they act as good prospects to aiding progressive teaching and learning whilst enhancing active learning amongst learners, when used appropriately.

2.3 Technology as a learning area

The subject Technology can be easily confused with technologies used in education i.e. Information and Communication Technology (which the study occasionally referred to as educational technology) which is often associated with computers, digital gadget and the internet which the research considers to be in its narrow view.

Technology as a learning area can be seen as a subject that is practical if not 'hands on', as learners continuously engage with the design process as means of solving technological problems. In Technology, it is compulsory for learners to familiarise themselves with the design process as to engage in the design, planning and making of the Mini- PAT. Learners work with machinery and tools to perform physical tasks using wood, paper, iron and various materials to compete a Mini-PAT.

The purpose of a technical subject like Technology is to assist learners to be technological literate so that learners;

- "Develop and apply specific design skills to solve technological problems.
- Understand the concepts and knowledge used in Technology education and use them responsibly and purposefully.
- Appreciate the interaction between people's values and attitudes, technology, society and the environment" (DBE, 2011, p.8).

The subject thus aims to equip learners with technical skills which they can use to solve everyday problems while the subject prepares them for the world of work. Technology prepares learners to tackle and solve everyday problems in a technological manner. The subject also equips learners with knowledge of gears, machinery and electronics in which they can use to in everyday situations.

According to the subjects' requirements by the CAPS document (DBE, 2011) in implementing and understanding the Design principles and processes of Design within the subject; learners and designers will be able to understand the purpose of the subject and demonstrate the following attributes according to the subject's requirements:

- an **understanding** of the problem, need or opportunity;
- **knowledge** of the design process;

- **knowledge** of types and properties of suitable materials, and how to use them optimally;
- the ability to **calculate** the quantities and costs of the materials needed;
- **knowledge** of the conventions / building codes;
- an ability to **sketch** initial ideas on paper etc.

Learners need to work collaboratively with others; doing practical projects using a variety of technological skills (investigating, designing, making, evaluating and communicating) to suit different learning styles (DBE, 2011, p.11). The subject encourages learners to work with others apart from equipping them with the necessary knowledge that will enable them to be active members of society.

The subject aims to prepare learners with the basic knowledge needed to prepare them for the world of work and help them to become active citizens so that they can put to use the skills that they have learned in school in the real world. Teachers teaching the subject are expected to have mastered the content related to the subject to be able to teach it. Furthermore it is expected that “in both primary and secondary schools, the teaching of basic computer principles and word processing skills forms the most important component in the teaching of computer literacy” (DoE, 2004, p.19).

2.3.1 Understanding Mechanical Systems Control

Mechanical systems and control is an area of technology that deals with mechanism and control systems. According to the CAPS policy document (DBE, 2011) mechanism “are parts that can turn one kind of force into another and give mechanical advantage or a distance advantage. Mechanisms can be combined to form a machine. The basic mechanisms are the lever and the wedge/inclined plane. Cams/ cranks and pulleys/gears are adaptations of the wheel and axle – which is itself a special case of the first class lever”. These devices are able to do mechanical work. They explain and give a clear indication on how hydraulic systems work in order to operate machines like the hydraulic press, car jacks and hydraulic lifts.

Mechanical systems involve different parts that are joined together to perform a specific function. A system is a group of components connected so that they work together to perform a task.

The component parts may be ordered steps in a procedure or organizational structure but we need only concern ourselves with physical components each of which has its own contribution to make to the overall operation of a system. All systems consist of at least three clearly identifiable sections. The input stage is where energy or information is fed into the system. The process stage is where energy or information is processed or converted. The output stage causes something to happen.



Figure 3. Mechanisms operational system (Source: DBE, 2010)

The energy source of the system will determine which type of component is required at each stage. If the energy source is compressed air the components will need to be pneumatic components and these will combine to produce a pneumatic system. If the energy source is electricity the components will need to be electrical or electronic and these will combine to produce an electronic or electrical system. The energy input into a system can be:

Movement - (mechanical systems), Oil/water under pressure - (hydraulic systems), Air under pressure - (pneumatic systems), Electricity - (electrical or electronic systems).

Mechanical Systems

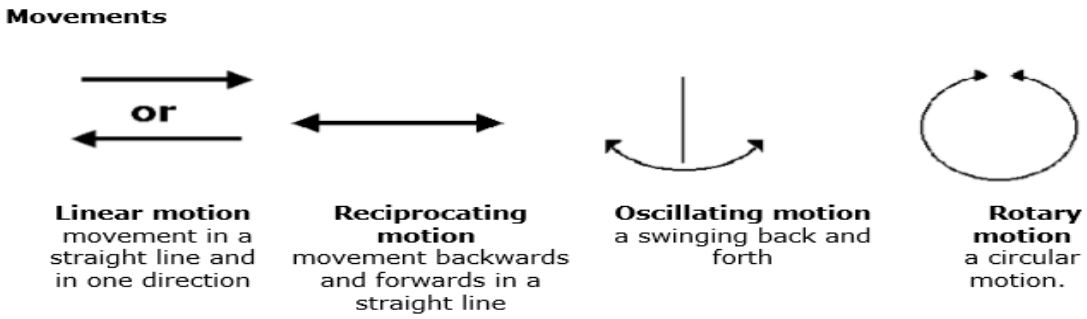


Figure 4. Energy source systems (Source: DBE, 2010, p.42)

A lever is a rigid bar that can turn on a fixed point called a fulcrum (pivot) (Mfusi et al, 2011, p.141). Levers can be used to multiply the force, change direction of the force or change the distance through which the force acts. Mfusi (2011) highlight three types of levers in which the fulcrum (pivot), the effort, and the load are arranged in different ways:

- A first class lever changes direction of the force, with the fulcrum between the load and the force. The load is on one of the side of the fulcrum, and the force is on the other side of the fulcrum. When the force pushes down on one end, the load moves up at the other end. The closer the load is to the fulcrum, the less force it takes to lift the load. An example of a first class lever is a seesaw.
- A second class lever multiplies the force, with the load between the force and the fulcrum. The direction of the force stays the same as the load. The force of the load is increased, but the load will not move as far. An example of a second class lever is a wheelbarrow.
- A third class lever multiplies the distance through which a force acts, with the force between the load and the fulcrum. The force and the resistance are moving in the same direction. An example of type of lever is your elbow and your lower arm. The fulcrum is your elbow, and the resistance is your hand. The force is applied in the middle by your biceps muscles.

A mechanism that is made by connecting levers is called a linkage. Levers and linkages are bars that are joined together to perform a task. Linkages are used to change the direction of force or movement, for example from push to a pull, or from a pushing movement to a turning movement (Mfusi, 2011, p.145). In real life situation,

we have examples of levers which learners use daily like a pair of scissors, see-saw, knifes, spoons and fish rod. The concept of levers and linkages help learners to master the world around them, and makes them understand that without mechanical systems and control certain jobs were not going to be successful.

Machines unlike people are to produce powerful forces to do simple and hard jobs such as lifting cars, digging big holes and compressing large objects. Machines that are best tasked at doing these jobs seldom use gears, pulleys or levers. These machines use hydraulics to do the work. Another competent of mechanical systems and control is of hydraulic systems and pneumatic system. Hydraulic machines use oil or water in strong cylinders to create powerful forces (DBE, 2010, p.421). Hydraulics operates with compressed liquids to produce an output force. The liquid needs to be pumped from the reservoir to push the output cylinder. The use of hydraulic machines is an efficient way of gaining mechanical DBE, 2010, p.41). Also, control mechanisms in hydraulic systems allow you to direct the flow of fluid to your advantage (DBE, 2010, p.41). Learners have to understand the concept of hydraulics systems as this will help them in their design and creation of Mini PAT of Mechanical Systems and Control and its Mini-PAT.

DBE, 2010, p.41) highlights the advantages and disadvantages of hydraulic systems:

- The biggest advantage of hydraulic systems is that you can create very large output forces. You can also make hydraulic cylinders in any shape. This allows you to reach difficult places, for example around corners.
- The disadvantage of hydraulic systems is that they are expensive to build. The parts of a hydraulic system are expensive and have to be extremely strong to withstand the high forces generated by the system. You must also keep hydraulic fluid clean so that it does not clog up the system.

Pneumatic systems are often found in machines and tools that operate using compressed air. Compressed air is air that has been forced into a small space. “Compressed air is an efficient way of using energy. When air has been compressed, it has potential energy to expand again. Pneumatic systems use the

potential energy of compressed air to make machines and tools work" (DBE, 2010, p.41).

DBE, 2010, p.42) highlights at least four parts to a pneumatic system:

1. A compressor compresses the air going to the receiving cylinder.
2. Air lines or pipes transfer the compressed air to the receiving cylinder.
3. A receiving cylinder uses the compressed air.
4. Valves control the flow of compressed air.

A jackhammer is a good example of a device that uses a pneumatic system. The receiving cylinder of the jackhammer uses compressed air to force a piston downwards. A drill bit is attached to this piston. The drill bit digs into the ground or breaks up rocks. A compressor near the jackhammer compresses air. The compressed air flows along an inlet airline to the receiving chamber of the jackhammer and forces the piston down. As the piston moves down, a valve closes over the inlet airline. When the piston has moved down far enough, the compressed air rushes out of an outlet pipe. A strong spring at the base of the piston forces the piston up again. The valve over the inlet airline opens. Compressed air rushes into the receiving chamber and forces the piston down again.

When teaching pneumatic system, the educator must be able to explain how pneumatic systems operate. Educator must be able to demonstrate how pneumatic systems work using syringes and bicycle pump. In practice, teachers habitually demonstrate pneumatic systems in their classroom using two syringes and a rubber tube. They would push down on the top of the piston of the syringe on one side and the piston of the other syringe rises. In essence a pneumatic system is a branch of Mechanical System and Control that deals with compressed air.

Mechanical advantage in pneumatic systems

Mechanical advantage is gained by using pneumatic systems. (DBE, p.42) demonstrates that if you increase the area of the base of the output piston, then the force at which the piston rises will also increase: For example, in the diagram the area of the base of the input piston is 10 cm^2. The area of the base of the output

piston is 50 cm². If you push down on the first syringe with a force of 5 N, then the second syringe will rise with a force of 25 N. The force is five times stronger. The distance travelled by the output piston will be a fifth of the distance travelled by the input piston.

When teaching the control devices, the teacher must understand how the control devices must work to control different mechanisms. Example of control devices are one-way valve on the soccer ball, the ratchet system and the cleat system. The educator must help learners understand how the control systems work so that they will understand how certain mechanisms operate in real life situations.

2.4 Forms of teacher knowledge

Teachers play an important in transmitting knowledge and in helping students understand specific subject matter. The latter then makes teaching to be a very complex and important process in helping learners acquire the necessary knowledge to enable them to be active members of society. The teachers' knowledge and competency in their subject matter is both crucial and important in the teaching process. The current education system maintains that effective teachers are teachers who are able to use an array of teaching strategies in different combinations to assist learners in the learning process as means of improving and achieving learning outcomes. The study has discovered that some strategies are better suited to teaching certain skills and fields of knowledge than are others. The teacher knowledge and the manner in which they are able to scaffold and represent knowledge to their learners play an important part in realising and achieving effective teaching and learning. Equally important to teachers' knowledge is the issue of Globalisation in the educational context which the study realised that it advocates for the practicality and physicality of instruction. In this segment, the study discussed teachers' knowledge in relation to ICTs in education.

Integrating technology is not about technology – it is primarily about content and effective instructional practices. Technology involves the tools with which we deliver content and implement practices in better ways. Its focus must be on curriculum and

learning. Integration is defined not by the amount or type of technology used, but by how and why it is used. (Earle, 2002, p. 8 cited in Niess et al, 2009, p.7)

The teacher plays an important in transmitting knowledge and in helping students understand specific subject matter. The quotation above highlights the complexities involved in teaching with technology. Factors that shape, influence and contribute to teacher's high quality of teaching and their pedagogy is Pedagogical Content Knowledge (PCK). Teachers PCK according to Shulman (1987) entails the ways content, pedagogy, and knowledge of learners are blended together into an understanding about how particular topics to be taught are represented and adapted to learners' characteristics, interests, and abilities. PCK informs how the teacher teaches a particular content to learners in different context. PCK is the content knowledge that the teacher possess regarding how they can teach a specific content using different strategies. This specialized knowledge allows teachers to use the most effective methods for teaching specific content. Therefore it is important that the teacher has a strong grasp of PCK and master their subjects in order to be able to open up or solidify the knowledge and information they wish to impart on learners. The teacher will also be able to use and integrate ICTs properly in their lessons. The teacher's ability to select, sequence, pace and evaluate a lesson, all highlights the level of understanding and knowledge the teachers has in order to be able to take into account learners needs, diversities, interests, abilities and background using technology in their teaching, thus influencing the teachers' competency in integrating and using technology. The importance of ICT integration then lays in the teachers' ability to master their content before using technology, therefore one is depended on the other for success or failure of ICT integration and use. ICTs in this regard cannot be seen as remedies to solving educational problems or challenges that teachers face in practice. Rather, ICTs can be seen as tool that the teachers can use to enhance teaching and learning in practice. This segment outlines the frameworks that can be used to help teachers develop skills and knowledge that will enable them to integrate and use ICTs in their teachings.

The belief that teachers' poses a unique knowledge that is different from other disciplines is true but the profession remains greatly undermined. Shulman took to look into the manner in which teachers transmit the knowledge that they have to their learners. Knowledge for teachers would necessarily be based on a framework for

classifying both the domains and categories of teacher knowledge, on the one hand, and the forms for representing that knowledge, on the other (Shulman, 1986, p.205). This then brings us to the notion of PCK.

2.4.1 Introducing Pedagogical Content Knowledge

According to Shulman (1987) PCK is a blending of content and pedagogy in order to enhance the understanding of how particular topics, problems, or issues are organized, represented, and adapted by the teacher to spark interest in learning from learners while moving them across the various levels of cognition and knowledge acquisition.

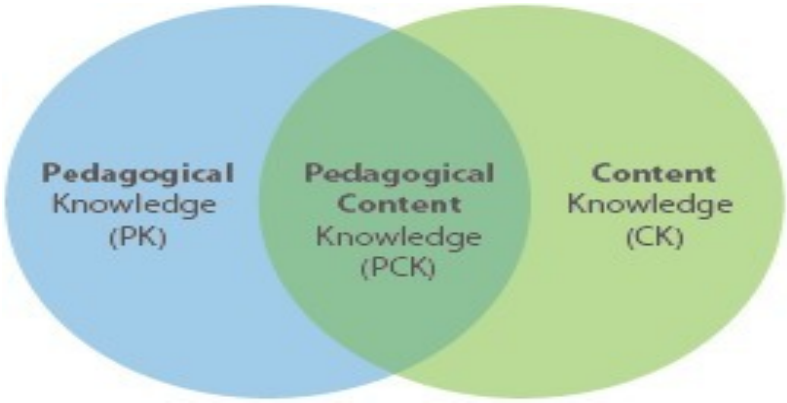


Figure 5: The PCK Model (Source: Shulman (1987)

These are informed and shaped by the knowledge bases that the teacher needs to have in order to make pedagogical decision to better transmit knowledge to the learners, Shulman (1986, 1987) understands theses to be; **content knowledge**- refers to the amount and organization of knowledge per se in the mind of the teacher, general pedagogical knowledge has special reference to the principles and strategies of classroom management and organisation, **curriculum knowledge**- is represented by the full range of programs designed for the teaching of particular subjects and topics, **pedagogical content knowledge-** goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching, knowledge of the leaners and the characteristics, knowledge of educational context- ranges from workings of group or classroom, the governance and financing of school

districts, to the characters of communities and cultures and knowledge of pedagogical ends- purposes, and values and their philosophical and historical grounds. These knowledge bases inform and shape the teachers pedagogies and practice. It is important that the teacher has and knows the knowledge of their discipline (subjects that they teach) and the educational knowledge (which is informed by teaching methodologies and pedagogies) that help put knowledge across.

The methods of teaching that the teacher uses to cover lessons and assessments is better developed using PCK through scaffolding and within sequencing learning within a specific context. Teachers need to develop their knowledge to better transfer the knowledge they want to impart to learners. The PCK model stresses that pedagogy cannot be divorced from content and is therefore filled, informed and conditioned by it. Consequently, Mishra and Koehler extended Shulmans idea and integrated technology (in this instance ICTs) as an additional element to the model that led to the development of the TPACK model. The TPACK model is seen as a conceptual framework that teachers can use as a guide as means of integrating ICTs into their lessons.

2.4.2 Understanding Technological Pedagogical Knowledge (TPACK)

According to Mishra and Koehler (2008), teaching with technology is an overlap between subject matter content, technological knowledge, and pedagogical processes used by teachers in their endeavour to promote student learning (Mishra and Koehler, 2008, cited in Jaipal & Figg, 2010). TPACK is designed around the idea that content (what teachers teach) and pedagogy (how they teach it) must be the basis for any technology that the teacher plans to integrate and use in their classroom to enhance learning.

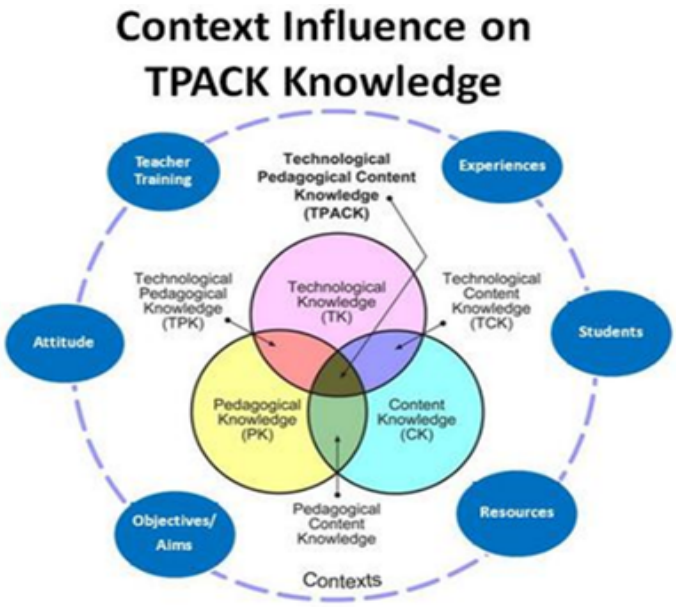


Figure 6: **Technological Pedagogical Content Knowledge framework. (Source: Mishra and Koehler (2008)**

Content knowledge (CK) refers to the knowledge regarding the subject that the teacher teaches. It is the "knowledge about actual subject matter that is to be learned or taught" (Mishra & Koehler, 2006, p. 1026). Teachers must know the content they are going to teach and how the nature of knowledge is different for various content areas.

Pedagogical knowledge (PK) refers to the methods and processes of teaching and includes knowledge in classroom management, assessment, lesson plan development, and student learning. This generic form of knowledge applies to understanding how students learn, general classroom management skills, lesson planning, student assessment […] the nature of the target audience, and strategies for evaluating student understanding (Koehler, Mishra, Cain, 2013, p.14). It encompasses the knowledge of the subject the teacher has and the method of practice that informs their thinking and principles.

Pedagogical content knowledge (PCK) refers to the content knowledge that deals with the teaching process (Shulman, 1986). Pedagogical content knowledge is different for various content areas, as it blends both content and pedagogy with the goal being to develop better teaching practices in the content areas.

Technology knowledge (TK) refers to the knowledge about various technologies, ranging from low-tech technologies such as pencil and paper to digital technologies such as the Internet, digital video, interactive whiteboards, and software programs. It requires the teacher to have “a deeper understanding and mastery of information technology for information processing, communication, and problem solving (Jaipal, & Figg, 2010, p.418). Teachers need to be able to adapt to changes relating to technology in order to have developed an understanding of working with technology and its various tools as means of recognising when technology can promote educational achievement or hinder it.

Technological Content knowledge (TCK) refers to the knowledge of how technology can create new representations for specific content. It entails “an understanding of how teaching and learning changes when particular technologies are used which includes knowing pedagogical affordances and constraints of a range of technological tools as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies” (Koehler & Mishra, 2008 cited in Jaipal, & Figg, 2010, p.419). It suggests that teachers understand that, by using a specific technology, they can change the manner in which learners practice and understand concepts in a specific content area.

Technological pedagogical knowledge (TPK) refers to the knowledge of how various technologies that can be used in teaching, and to understanding that using technology may change the way teachers teach. It is the knowledge of the existence, components, and capabilities of various technologies as they are used in teaching and learning settings, and conversely, knowing how teaching might change as the result of using particular technologies (Engida, 2013). TPK highlights the skills the teacher uses that supports a technology to enhance a particular pedagogical approach, that will enable the teacher to represents digital tools in multimodal presentational manner in their lessons. Also identified by Mishra and Kohler (2006), TPK helps teachers to identify and select the best technologies to support their students as they learn content.

Technological pedagogical content knowledge (TPCK) refers to the knowledge that is required by teachers for integrating technology into their teaching of any content area which allows creativity. Teachers need to have an intuitive

understanding of the complex interplay between the three basic components of knowledge CK, PK, TK by teaching content using appropriate pedagogical methods and technologies. The latter will allow development of knowledge within a particular context. Identified by Mishra and Kohler in 2006, TPACK comprises of is the set of skills which teachers need to develop and be able to identify the best technology to support a particular pedagogical approach.

The variables that are displayed outside the ring on the diagram represent some of the variables which contribute to and impact all areas of TPACK. The variables inside the circles demonstrate the relationship that exists between the Technological, Pedagogical, and Content Knowledge to create TPACK and these areas coexist and influence each other. The variables outside of the circle highlight the matrices that influence the variables inside the circle and reveal that teachers competencies, values, attitudes and believes to name a few impact the succession in applying TPACK and ability to integrate technology in their teaching.

Therefore, teachers past experiences with technology also would contribute to their Technological Knowledge. The diagram highlights the seven components that are included in the TPACK framework as well as some of the variables, which help shape and impacts teachers Technological, Pedagogical, and Content Knowledge. Outlined first was the seven components that build on the TPACK framework. TPACK highlights the manner in which teacher's development in using ICTs impacts the design of professional development and classroom practices. Furthermore, TPACK is required for ensuring the efficiency of teaching and learning. The experience that the teacher undergoes during the different processes or level of TPACK of the processes enriches and strengths the kinds of knowledge the teacher has. Additionally, Angeli, & Valanides (2013) recognise that "TPCK can be developed as a unique body of knowledge in powerful learning environments where technology teaching is situated in real and authentic design tasks, and in ways that teacher educators explicitly teach about the educational affordances of tools". TPACK is a useful model for educators as they begin to use ICTs and digital tools strategies to support and facilitate progressive teaching and learning.

2.4.3 Developing TPACK

In developing TPACK concerning teacher education and development, Koehler et al suggests three paths: **First path, 'From PCK to TPACK'**. In this approach, technology is introduced as a way to support and enhance the strategies already being used in the classroom (Koehler, Mishra & Cain, 2013, p.106). These centres on the years of experience the teacher has been teaching that can enable the teacher to incorporate technology into their existing knowledge of content. A problem with this approach is that "activity types are seen as content-specific" thus the focus is on "learning goals, and based upon pedagogical decisions" (Koehler, Mishra & Cain, 2013, p.107). The approach is rooted on teachers' beliefs and habitus as a result teachers tend to become too comfortable in mastering and knowing content and be reluctant to integrate ICTs into their teaching.

Second path, "From TPK to TPACK". This approach involves a pre-service candidate who has had not yet taken content-specific methods courses when he/she is required to take a prerequisite technology integration course (Koehler, Mishra & Cain, 2013, p.107). The technology integration courses tend to focus on how technology can support teacher productivity and general pedagogical strategies. Furthermore, as pre-service take methods courses specific to their content specialty, their knowledge of TPK should expand into TPACK, and they should incorporate their knowledge into their disciplinary understandings (Koehler, Mishra & Cain, 2013, p.107). The approach is geared at looking at what technology can offer, how it can support the teacher in their teachings and how the teacher can use or incorporate technology into their pedagogies. A problem with this approach aside from it being viewed as a "default approach", is that "the affordances of a tool may facilitate or make difficult certain pedagogies" (Koehler, Mishra & Cain, 2013, p.107) as the pathway is not connected to pedagogy. However a succession in the TPK to TPACK is linked to "the technology mapping approach [which] emphasizes mapping or connecting the properties of technological tools with the ability to transform content representations and/or support student-cantered pedagogies (Koehler, Mishra & Cain, 2013, p.107).

Third path, Developing PCK and TPACK Simultaneously. This approach tries to "develop PCK and TPACK simultaneously" (Koehler, Mishra & Cain, 2013, p.107). This means replacing the educational technology course, as we know it, with a systematic integration of technology-supported strategies into the methods courses and field experiences (Koehler, Mishra & Cain, 2013, p.107). In essence the approach proposes that teachers should receive training in the main areas of knowledge being; content, pedagogy and technology. One challenge of this approach is the cognitive load that students [and teachers] experience when they are simultaneously trying to develop their pedagogical, content, and technological knowledge (Koehler, Mishra & Cain, 2013, p.107). A solution to this problem is incorporating "Learning Technology by Design approach (Koehler & Mishra, 2005a, 2005b cited in Koehler, Mishra & Cain, 2013, p.108). In this approach, teachers develop TPACK by working in teams to design solutions to ill-structured, real-world problems of teaching and learning over an extended period of time (Koehler, Mishra & Cain, 2013, p.107).

Furthermore, in addressing problems that arise when integrating ICTs, although related to Mathematical classroom, it remains relevant for the study. Rogers (1995) and other researchers propose and "describe a five-stage, sequential process by which a person makes a decision to adopt or reject a new innovation" (Roger, 1995, cited in Niess et al, 2009, p.7). Five stages are that teachers go through as means of developing are as follow:

1. Recognizing (knowledge), where teachers are able to use the technology and recognize the alignment of the technology with mathematics content yet do not integrate the technology in teaching and learning of mathematics.
2. Accepting (persuasion), where teachers form a favourable or unfavourable attitude toward teaching and learning mathematics with an appropriate technology.
3. Adapting (decision), where teachers engage in activities that lead to a choice to adopt or reject teaching and learning mathematics with an appropriate technology.
4. Exploring (implementation), where teachers actively integrate teaching and learning of mathematics with an appropriate technology.

5. Advancing (confirmation), where teachers evaluate the results of the decision to integrate teaching and learning mathematics with an appropriate technology. (Rogers, 1995 cited in Niess et al, 2009, p.7)

Koehler, Mishra & Cain (2013) highlight that the development of TPACK is clearly an important area of research, due to its significant implications for teacher education and teacher professional development. What is evident and needs to be evident is developing an understanding that using technology is not the same as teaching with it. The focus of the frameworks presented by the study was to provide an educational context for the successful development of ICT skills in an attempt to integrate ICTs successfully and harness its benefits. The figures presented highlight the phases of competence and reveals that as a teacher progresses through different levels, stages and phases. The activities created demand greater higher order thinking skills and further sums up the discussion.

In an attempt to use TPACK as a lens to highlight teacher's competency in teaching the subject and using technology, I decided to look at how ICTs are currently integrated in practice and the teacher's role and expectation in the integration and implementation process. Aspects of TPACK that form basis in achieving this were outlined in chapter 4, they are; TK, TPK and TCK during data analysis and interpretation.

2.5 Modes of integration

There is a consensus between researchers that before integration can happen; teachers need to have a clear understanding of what ICTs are and how to use them in their lessons. This means that teachers need to be ICT literate and have a good ICT pedagogy in order of successfully integrate ICTs in their lessons. ICT literacy is what enables teachers to use ICT practically in different context in order to make learning more efficient. ICT integration is about having the "appropriate selection, use, mix, fusion and integration of many sets of competencies including, but not exclusively, those in pedagogy and technology" (ICT in Education, UNESCO; 2003

cited in the DoE, 2007, p.4). Teachers are required to be able to use and integrate ICTs in their lessons using different repertoires. For ICTs to be effectively integrated and used appropriately the following ICT development levels are to be included in the framework:

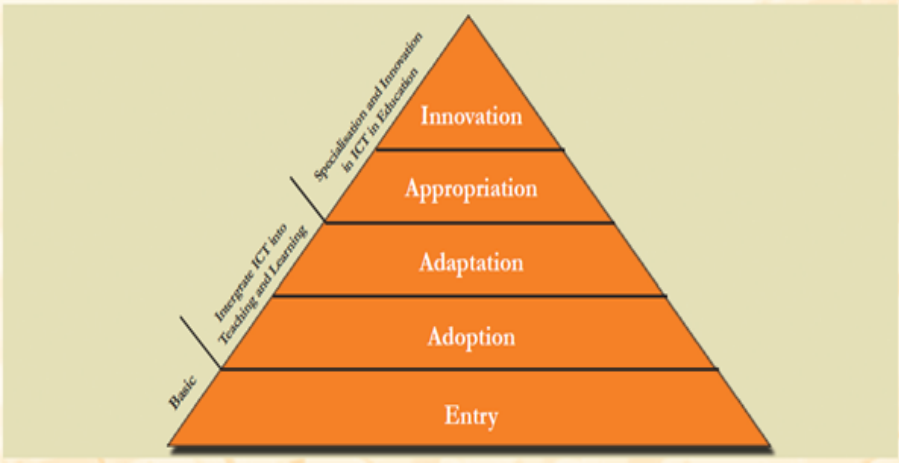


Figure 7: **Levels of integration (Source: The teacher development framework (2007)**

Entry level

In this level "the teacher is computer literate and is able to use computers" (DoE, 2007, p.6). The teacher is likely to lack confidence when using ICTs in their classrooms. Even though at this level, the teacher may still be battling with certain frustrations and insecurities relating to using ICTs and integrating them in their lesson. The teachers in this study are passed this level due to the ICT training and workshops that they had received prior to using ICTs in their classrooms and they still receive training.

Adoption level

From having basic skills of using ICTs, in this level "the teacher is able to use various ICT, including computers, to support traditional management, administration, teaching and learning, and is able to teach learners how to use ICT" (DoE, 2007, p.6) in their lessons. The teachers teach using smartboards and other technology

devices (laptops and projectors). They also prepare lesson plans, learners' marks and reports using laptops and software's like Microsoft office and Smartshare.

Adaptation level

From being able to use ICTs to teach in the classroom, "the teacher is able to use ICT to support everyday classroom activities at an appropriate NCS [National Curriculum Standard] level, assess the learning that takes place and ensure progression" (DoE, 2007, p.6). The teacher is able to not only integrate ICTs but use it for different uses as means of exploring its use and possibly reflect on the changes they see in the teaching and learning process. An example of this is in the preparation of Mini-PAT. Teachers design a blueprint of the project in their laptop and project it on the Smartboard by either using High-Definition Multimedia Interface (HDMI) cable or Universal Serial Bus (USB) stick and then build a live replica of the design to present in class.

Appropriation level.

In the progressing from the first three stages "the teacher has a holistic understanding of the ways in which ICT contributes to teaching and learning" (DoE, 2007, p.6) and they have developed vast understating of using ICTs. The teacher in this level is now able to discover on their own, new ways to use ICTs in their lessons and is more confident in using ICTs that they were when they were in the beginning. The teachers in this study have shown competence in the first three levels and have not yet progressed to this level. This is because certain aspects of using ICTs teachers have not mastered yet. Some teachers still battle to represent different design drawings using the ICTs available in their classrooms. Teachers are still reliant in using textbooks and paper for free hand drawing and design rather than using design and drawing software's such as Autodesk, Solid works, SketchUp and ArchiCAD to name a few. Therefore, I can say that teachers are slowly developing skills that can make them to use ICTs in this level.

Innovation level

When the teacher has successfully progressed through the previous levels, they will be “able to develop entirely new learning environments that use ICT as a flexible tool, so that learning becomes collaborative and interactive” creating learning experiences that refine the normal classroom environment. Teachers do collaborate and share their resources and material with other teachers in terms of supporting each other. As highlighted teacher have not mastered the previous stage thus in this stage, teachers are not able to fully explore ICTs within their lessons.

2.5.1 Using TPACK to look at how pedagogy influences the planning process

In terms of planning, TPACK shapes planning of information or knowledge that is to be imparted to the learners. In the emerging process whereby TK is the centre, the teacher needs to be able to design lessons that will support learners in acquiring knowledge and information. The teachers’ effective use in using technology can influence design and the design process. In the applying process TCK is a driving force as the teachers competence affects the manner in which ICTs are utilised and integrated into the lesson and classroom thus influencing its frequency. The teachers’ content knowledge of the subject and the technology knowledge help them to be able to create activities that can assist learners grasp content of the subject. Lastly the infusing process highlights the teacher’s level of TK, TCK and TPK, the teacher’s ability to use different representation to enhance the activities and engage learners in the learning process.

The implementation process highlights the various aspects that need to be taken into consideration in the development and implementation of ICTs in practice. This brings about clarity and coherence to the complex matrix of teacher education activities that derive from the initial recruitment and preparation to self-motivated professional development that exist. From the discussion above, it is eminent that some strategies are better suited to certain levels of TPACK to be able to address the needs of the learner whist taking into consideration their backgrounds, learning styles and abilities.

2.6 Teachers' competency in integrating ICTs

Technology in schools opens a whole new world that could be explored by both the teachers and learners thus creating endless learning possibilities for all. Technology allows them to have access to a wide range of information to name but a few. According to UNESCO (2002), "ICTs have the potential to transform the nature of education—where and how learning takes place and the roles of students and teachers in the learning process (UNESCO, 2002 cited in Engida, 2013, p.9). When teaching with ICTs, it is crucial that teachers are competent so as to be able to use ICTS appropriately and effectively. "Competence inheres in the actual performance of an agent in carrying out the occupational and professional tasks of a job by putting appropriate SKVAs [skills, knowledge, value and attitude] into practice in the performance".

The latter gives rise to a framework that teachers can use and be measured on to check for their competence. "A Competency Framework is a set of defined competence statements which frame the kind of practices that would be expected (based on a consensus of a specified set of stakeholders) of agents in specific contexts and environments". The ICT Competency Framework for Teachers is aimed at helping countries to develop comprehensive national teacher ICT competency policies and standards, and should be seen as an important component of an overall ICT in Education Master Plan (UNESCO, 2011). The framework seeks to define what teachers should know as it affects their practice and methods used, and what they should be able to do to improve in their profession. The competency frameworks that were reviewed in this study comprised of competency statements. These were highlighted in each of the frameworks as they reveal educational objectives that are structured in a manner that highlights competence statements. The competence statements of each framework incorporate level similar to those identified in Blooms Taxonomy. The verb form of each framework relates to the development levels within the framework which demonstrates the different types of knowledge that the teacher needs to have in order to be able to use technology in their teaching, as means of conveying the quality of the level as means of reflecting teaching into practice. The noun aspects within the frameworks relates to the dimension of the framework. They highlight observable behaviour that the teacher needs to exude as means of integrating technology into their lesson. Therefore

competence statements need to have all these components for a competency to be identified, and for a competence to be framed or designed.

A competence statement integrates the different knowledge and skills that the teacher should have their values, abilities and attributes (teachers' habitus) as means of elaborating their competence in using and integrating technology into their teaching. Teachers' competency lies in them integrating the competence statement and applying them in practice (real world situations) and their ability to carry these competence statements out into their lessons when using technology in the classroom. In essence competency lies in what teachers can actually do using a competence statement as a guideline to inform their practice. The competency framework serves as guidelines that teachers can use to know what is required of them and the type of training needed to meet teaching objectives and goals when integrating technology in their lessons.

The ICT competency standards for teachers that has been designed by UNESCO aims to help educational policy-makers and curriculum developers to identify the necessary set of skills the teachers need in order to harness technology in their practices. It then becomes important that the teacher is competent and able to utilise these ICTs in an appropriate manner.

The ICT Competency Standards for Teachers (ICT-CST) were designed by UNESCO to help educational policy-makers and curriculum developers identify the skills teachers need to harness technology in the service of education (Ministry of Education Rwanda, 2010, p.12). The ICT-CST was developed to provide teachers with guidance on how to improve their practice through ICT use. Furthermore, "the ICT-CST constitutes a set of standards and resources that provide guidelines for planning teacher education programs and training offerings that will prepare teachers to play an essential role in producing technology capable students" (Ministry of Education Rwanda, 2010, p.12).

The Teachers Competency and Qualifications Framework in the use of ICTs in Education (eTQF) are "designed to help teachers identify their own ICT competencies and the degree to which they can integrate ICT in their teachings. It is based on the UNESCO ICT Competency Standards for Teachers and has integrated an "Introductory" level to the continuum of approaches for integrating ICT in

educational delivery" (Ministry of Education Rwanda, 2010, p.12). The eTQF makes qualifications to be more readable and understandable across countries and systems. It provides support cross-border mobility of teachers and learners and encourages lifelong learning not only across Europe but also within other countries.

Within the subject technology, teachers need to have mastered the knowledge of the subject in order to be able to integrate ICTs properly using their pedagogies. It is also worth noting that teachers respond to technological integration based on existing educational beliefs and experiences (Ertmer, 2006).

2.6.1 Teachers' habitus and beliefs about ICT integration in the classroom

According to Pajares (1992), teacher habitus and beliefs are created through a process of enculturation and social construction; they can be formed by chance, an intense experience, or a succession of events (Pajares, 1992, cited in Ertmer, 2006, p.30). Ertmer (2006) recognises that the beliefs teachers hold influence their perceptions and judgments, which in turn, affect their behaviour in the classroom. Therefore, teachers' habitus, believes and attitudes remains a driving force in the integration and implementation of ICTs in the classroom

It is important that we acknowledge and recognise that we are now part of an era of globalization whereby ICTs have become an integral of teaching and learning, thus influence and shape educational instruction and practice. Marcinkiewicz (1993) noted that "full integration of computers into the educational system is a distant goal unless there is reconciliation between teachers and computers (Marcinkiewicz, 1993 cited in Ertmer, 2006, p.27).

Ertmer (2006) highlights three strategies that seem promising for promoting change in teacher beliefs about teaching and learning with technology and they are; (a) **personal experiences**,- which are "formed through personal experience" thus allows the teacher to build confidence to adopt new practices, (b) **vicarious experiences**,- which are "experiences for building teacher confidence and competence" and (c) social-**cultural influences**- acknowledges that "teachers' practices and beliefs are continually shaped by their ongoing experiences as teachers, by the values and opinions expressed by those around them, and by the

expectations of influential others, all of which are transmitted through formal and informal norms, rules, and procedures(Becker and Riel, 1999 cited in Ertmer, 2006, p.34). Therefore, these strategies are predicated on the idea that beliefs are grounded in experience and authority, as described above (Nespor, 1987; Rokeach, 1968 cited in Ertmer, 2006, p.32).

2.6.2 Understanding teacher knowledge

Teaching is a complex activity that is premised upon the acquisition, integration and application of different types of knowledge practices and learning. A purely skills based approach, which relies almost exclusively on evidence of demonstrable outcomes as measures of success. Without paying attention to how knowledge should underpin these skills for them to impact effectively on learning, will produce technicians who may be able to replicate performance in similar contexts, but who are severely challenged when the context changes. In addition, the approach adopted in The Minimum Requirements for Teacher Education Qualifications pays close attention to the various types of knowledge that underpin teachers' practice, while encapsulating all of these in the notion of integrated and applied knowledge (DoE, 2015, p.9). Teachers are expected to possess certain competencies in order to be able to integrate and use ICTs successfully in practice.

Teaching in this light is seen as a very complex and crucial process that helps learners acquire knowledge, it therefore becomes important that the person responsible for imparting knowledge to others (the teacher) is knowledgeable and competent in their subject matter. The teacher needs to possess an adequate understanding of technological knowledge in order to be able to integrate ICTs successfully in practice to enhance learning. In essence, teachers are expected to be qualified and knowledgeable in their subject matter. Successful integration of ICTs in practice is influenced by the teachers' habitus, the society they exist in and the manner in which they use their pedagogies.

2.7 Teaching with ICTs in practice

According to Ghavifekr et al (2014) ICT is a shorthand for the computers, software, networks, satellite links and related systems that allow people to access, analyze, create, exchange and use data, information and knowledge in ways that were almost imaginable (Association of African Universities, 2000 cited in Ghavifekr et al, 2014, p.25). In this light, ICTs are seen as tools and a process that can be used in aiding better teaching and learning thus reducing viewing ICTs as hardware. In practice, teachers are only able to operate and use few aspects from those previously listed. This is mainly because ICTs are often seen teaching aids in practice thus the conflict in teachers experience and the manner in which they use ICTs in their teaching often arise. Within the subject Technology, a predominant practice observed when teachers integrated ICTs in practice was through projecting of videos, Word Document, Microsoft Excel document to the smartboard using the laptop.

Therefore teachers experience and successful integration of ICTs as means of transforming practice is dependent on personal experiences, vicarious experiences and socio-cultural influences, which draws heavily on the Social Cognitive theory. The theory is closely related to the social constructivist theory which “is based on the notion that learning is an active process that consists of constructing knowledge rather than acquiring knowledge and that instruction is the process by which this knowledge construction is supported rather than a process of knowledge transmission (Duffy & Cunningham, 1996 cited in Noor-Ul-Amin, 2013). Researchers and scholars have identified that “in this domain learning is viewed as the construction of meaning rather than as the memorisation of facts (Lebow, 1993; Jonassen & Reeves, 1996 cited in Noor-Ul-Amin, 2013). The latter recognises teaching and learning to be active process rather than a passive one. The teacher is constantly encouraged to create and transmit knowledge in a manner that is best suited to represents their lessons. I concur with writers who postulate that “learning approaches using contemporary ICTs provide many opportunities for constructivist learning through their provision and support for resource-based, student centered settings and by enabling learning to be related to context and to practice” (Berge, 1998; Barron, 1998 cited in Noor-Ul-Amin, 2013). The pilot schools thus far have displayed that with this learning environment methods of teaching and learning have changed, and continue to change.

In a revision lesson observed, the teacher was recapping design skills looking at 2D drawing in helping learners' complete their Mini PAT project. Leaners were grouped in groups of 8 and were provided with cudboard boxes, glue and scissors. Learners had to complete an activity before continuing to finishing their Mini PAT projects which had to show a structure with a mechanism for lifting a load. The drawings had to represent their final project. The teacher had displayed notes relating to 2D drawing and explained instructions for Mini PAT to their learners. Learners had to copy the information down in their textbooks while working on the Mini PAT in groups.

Technology as a learning area or subject does not have a lot of literature fairly because when the subject was introduced to the school curriculum in 2009, there has not been any update on the subject nor its literature. However, the literature reviewed in this study, on Educational Technology, covers a huge area of the subject and relates to the aspects of the subject that are relevant to and for this study. The findings of the study were aimed at understanding how effective of teaching and learning was achieved when ICTs are integrated into the subject Technology classroom, especially in teaching of the concept of Mechanical Systems and Control and its Mini-PAT. The study also addressed gaps related to the subject as means of getting insight of how the subject is in practice. The research has extrapolated literature on educational technology and learning with ICTs, both locally and international literature was explored, as means of predicting and highlighting teachers' effective use, competencies and readiness of ICTs in their teachings within secondary schools. In essence, successful integration and implementation of ICTs in practice are connected and influenced by teachers' personal beliefs about curriculum and instructional practice.

2.8 CONCLUSION

The purpose of this chapter was to present literature surrounding the study which was relevant in answering the research question: What difficulties do teachers have in implementing ICTs in the teaching of a Mini PAT in Mechanical System and control concept in a Grade 8 Technology class? The background relating to ICTs and their impact in in schools was touched on. The literature reviewed the

frameworks related to teaching using ICTs. The major framework used in this study was the TPACK framework. The framework was used as it allows teachers to assess the degree of technology integration and make judgements on how to best use ICTs in their classroom. The frameworks that have been reviewed in this study have a number of features in common. They contain taxonomy of competences organised into matrices. These matrices have three key dimensions. One dimension covers the various competence aspects that should be covered in the teacher development programmes. These are usually organised along the vertical axis of the matrix. Another dimension covers the different processes in teacher ICT-in-Education development usually starting with some sort of beginning level and advancing towards more advanced levels.

The literature reviewed on teachers' competencies and pedagogies highlighted that TPACK is more than simply adding ICTs into traditional approaches and has stressed that because technology is incorporated into the classroom, it does not necessarily guarantee successful teaching and learning. Teachers' competence and wiliness to use ICTs serve as a driving force in enabling effective and successful teaching and learning. Therefore, successful integration and learning depends on the level of knowledge of how to use ICTs and the teachers' ability to link it into the subject matter. Furthermore, the teacher needs to have an adequate understanding of how ICT can support and enhance teaching and learning in practice. Therefore it emerged from the literature reviewed on ICTs that using ICTs in class is not the same as teaching with technology nor does it guarantee effective teaching and learning. The next chapter outlines the qualitative paradigm, the site selection and provides a detailed account of the methods employed in the gathering of data.

Chapter 3: Research Design and Methodology

3.1 Introduction

The previous chapter dealt with literature review surrounding the integration of ICT in the classroom as well as the theoretical framework that underpins the study were explored. The literature revealed that successful integration and implementation of ICTs depends on the teachers' level of knowledge and skills of how to use ICT in order to be able to link it to the subject matter

This chapter provides insights into the research design and the methods that were utilised in the gathering and analysis of data as means of answering the research questions. The chapter presents; the qualitative research paradigm, purposeful sampling, site selections, background information of the participant, research methods, data collection, methods of data collection, classroom observation, the interviews that were conducted and ethical considerations were discussed and explored in detail.

3.2 Research design

Looking over the landscape of qualitative procedures shows diverse perspectives ranging from social justice thinking (Denzin & Lincoln, 2005) to ideological perspectives (Lather, 1991), to philosophical stances (Schwandt. 2000) to systematic procedural guide lines (Creswell. 2007; Corbin & Strauss. 2007 cited in Creswell. 2009, p.173). Research design refers to the plan or proposal in which the research will be conducted. It therefore involves "the intersection of philosophy, strategies of inquiry and specific methods" (Creswell. 2009, p.5). The study is situated within the Social Constructivist worldview which is often combined with Interpretivism. The study has adopted a qualitative approach for its methodology. Social constructivists uphold the notion that the individuals understanding of the world is individually and socially constructed by them based on their interpretations, experiences, background, and culture. Individuals develop subjective meanings of their experiences-meanings directed toward certain objects or things (Creswell. 2009, p.8). In short, social constructivists' worldview claims that individual perceptions of the world are influenced by their context, history, background making knowledge and

experience to be relative. This view therefore takes into account the works of Piaget and Vygotsky who are viewed as the major of Constructivism theory. Creswell (2009) highlights that the researcher's intent is “to make sense of (or interpret) the meanings others have about the world.

The paradigm attempts to create an environment that is both teacher and learner centred. Vygotsky (1978) states that learning is systematic co-operation between a learner (or learners) and a teacher, who is thus an active organiser of the frameworks of knowledge of learners (Vygotsky 1978 cited in Selepe and Moll, 2016, p11) and also stresses the role of mediation as means of promoting active learning and successive teaching. TPACK framework was used as a lens in order to understand the manner in which ICTs are integrated and used in the classroom to highlight their effectiveness in the teaching and learning process. The research draws from social constructivism worldview, which aims to explore the effectiveness of integrating ICTs in a Grade 8 Technology subject and its impact in the teaching of a Mini PAT in a Mechanical Systems and control as a topic.

Scott and Morrison (2006) assert that “qualitative research has come to denote research approaches that are underpinned by a set of assumptions about the way the social world operates”. This study adopted a qualitative approach as means of developing an understanding through observing how effective of teaching and learning was achieved when ICTs are integrated into the subject Technology classroom, especially in teaching of the concept of Mechanical Systems and Control and its Mini-PAT. The study acknowledged that ICTs were integrated and used in the classroom and the compatibility of ICTs in relation to teaching of a technical subject Technology. Qualitative research develops from the “assumptions of learning from the researchers” (Creswell, 2003, p.30) standpoint and “employs different knowledge claims, strategies of inquiry, and methods of data collection and analysis, and draws on diverse strategies of inquiry” (Creswell, 2003, p.179) as means of providing the researcher with answers to the problem inquest and thus is empirical in nature. Additionally, Scott (1996) supports that qualitative research uses interviews and is primarily concerned with the interviewee’s views and opinions on a range of phenomena that relate to the past and the present events.

The motive behind choosing a qualitative method was because the research pursues to understand participants' views, attitudes, opinions and actions in relation to the Technology subject matter and the impact or use of ICTs in their lessons as means of highlighting the effectiveness of teaching and learning was achieved when ICTs are integrated into the subject Technology classroom, especially in teaching of the concept of Mechanical Systems and Control and its Mini-PAT.

3.2 Qualitative research paradigm

In attempt to understand the purpose of this study, qualitative research and its paradigm was put into the fore. Kerlinger's (1979) defines theory "a set of interrelated constructs (variables), definitions and propositions that presents a systematic view of phenomena by specifying relations among variables, with the purpose of explaining natural phenomena" (Kerlinger's, 1979 cited in Creswell, 2009, p.51). This is in line with qualitative researcher's goals, as they aim to understand "how humans arrange themselves and their settings and how inhabitants of these settings make sense of their surroundings through symbols, rituals, social structures, social roles, and so forth" (Berg, 2001, p.7). Therefore, "qualitative research properly seeks answers to questions by examining various social settings and the individuals who inhabit these settings" as means of seeking answers to questions related to these settings.

Creswell (2009) postulates that "a theory explains how and why the variables are related, acting as a bridge between or among the variables". Thus qualitative researcher "employ theory as a broad explanation" (Creswell, 2009, p.70) as means of assisting them develop ways and understanding of solving a phenomena (problem) they are faced with. Creswell (2009) expounds that qualitative inquiry employs different philosophical assumptions; strategies of inquiry; and methods of data collection, analysis and interpretation. What distinguishes qualitative research from other types of research is its procedures. Qualitative procedures rely on text and image data, have unique steps in data analysis and draw on diverse strategies of inquiry (Creswell, 2009, p.173).

As mentioned before, “the intent of qualitative research is to understand a particular social situation, event, role, group or interaction” (Locke, Spirduso & Silverman, 1987 cited in Creswell, 2009, p. 194) and this all feeds into the qualitative paradigm. This in turn provides qualitative researchers with “a holistic picture of the subject of study with emphasis on portraying the everyday experiences of individuals by observing and interviewing them and relevant others (Fraenkel & Wallen, 1990 cited in Creswell, 2009, p.195). The researcher chose to embark on a qualitative enquiry because qualitative research was best in helping the researcher to understand the participants’ experiences and in “the identification of personal values, assumptions and biases” (Creswell, 2009, p.173) that the participant and the researcher develop throughout the study. This study particularly aimed at understanding the effectiveness of teaching and learning when ICTs are integrated into the subject Technology classroom, especially in teaching of the concept of Mechanical Systems and Control and its Mini-PAT. The study looked at how teachers use and integrate ICTs into their teaching. This helped the researcher understand the influence and impact ICTs have in the classroom.

3.3 Research epistemology

Philosophically, researchers make claims about what knowledge is (ontology), how we know it and (epistemology), what values goes into it (axiology), how we write about it (rhetoric), and the processes for studying it (methodology) (Creswell, 1994 cited in Creswell 2003, p.6). The study has highlighted that qualitative research tends to study things in their natural setting as means of trying to make sense of them; thus the enquiry supports and allows researchers to make use of the latter in an interpretive and naturalistic manner. As previously elaborated in the research design segment, this research adopted the socially constructed knowledge claims (which are often combined with interpretivism). Assumptions identified in these work hold that individuals seek understanding of the world in which they live and work (Creswell 2003, p.8). Consequently, “these meanings are varied and multiple, leading the researcher to look for the complexity of views rather than narrowing meanings into a few categories or ideas” (Creswell 2003, p.8). Due to the multiplicity of views and claims that the research participants provided, this knowledge claim

allowed the researcher to examine the development of these ideas and perspectives jointly as means of understanding the socially constructed assumptions of reality.

In an attempt to describe how human beings experiences and understands a certain phenomenon, as per qualitative enquiry requirement, this research made use of the phenomenology approach. The “phenomelogical approaches seeks to explore describe, and analyse the meaning of individual lived experiences: “how they perceive it, feel about it, judge it, remember it, make sense of it, and talk about it with others”(Patton, 2002, p.104 cited in Marshall and Rossman, 2011, p.19). Creswell (2003) adds that the procedures involved in this approach involve studying a small number of subjects in through extensive and prolonged engagement to develop patterns and relationships of meaning (Moustakas, 1994 cited in Creswell, 2003, p.15). Within this approach the research puts aside their biases and preconceived assumptions about the study relating to ones “own experiences in order to understand those of the participants in the study” (Nieswiadomy cited in Creswell, 2003, p.15).

This study research claims and approaches deemed flexible and appropriate for the study as they enabled the researcher and its participants to interact in natural settings thus provided the researcher with an in depth-knowledge and understanding of the research phenomenal under investigation. Classroom observations and interview were utilised to allow participants to share their perspectives and views with the researcher concerning the use and integration of ICT in a Technology classroom.

3.4 Research questions

Creswell (2003) states that in qualitative studies, investigators use research questions and hypothesis to shape and specify the focus the purpose of the study. Furthermore, these “research questions are interrogative statements or questions that the investigator seeks to answer” (Creswell, 2003, p.108). In essence the research questions in qualitative inquiry and the ones formulated in this study are answerable investigation pertaining the researchers’ quest. They are fundamental for any inquiry as they shape and influence what the study is about, its literature, its

analysis and the manner in which it will be reported. The purpose of research questions in this study aside from the previously mentioned was to present the parameters of the research problem. The study provided responses to the following questions posed on the research:

1. How are ICTs integrated in a Technology subject?
2. What are the gaps that exist in integrating ICTs into the subject?
3. How can ICTs be of significance in the preparation and delivery of a Mechanical system and control mini PAT?
4. What strategies do teachers use to enable effective teaching and learning using ICTs in the subject?

The questions addressed above were answered through the use of semi-structured interviews and classroom observation. Interviews were recorded for issues relating to accuracy, trustworthiness, validity and to enable the researcher to later transcribe the teacher's responses during the interviews when transcribing the data during analysis and interpretation. The analysis of the study included looking at the teacher's capability to use ICTs in their teachings and lesson and the manner in which they use ICTs (highlighting their challenges and strengths in using ICTs) as teachers were trained by the department and received individual training during teacher workshops. It was noted that the teachers' ability to use ICTs influenced attitude and the frequency and manner in which the teacher uses ICTs in their classrooms and lessons contributed to the effective of teaching and learning. Teachers from both schools used smartboards, laptops, tablets and whiteboards.

3.5 Research methods

The study made use of qualitative research approach to collect data. According to Scott (2010) qualitative research is "used to uncover trends in thought and opinions, and dive deeper into the problem" people are faced with. The study made use of interviews as well as classroom observation with the four Grade 8 Technology teachers from the two different schools. The study followed a qualitative method research design which incorporates interviews and observation of the Technology teachers. Qualitative method of research focuses on "the concepts, assumptions,

expectations, beliefs, and theories that support and informs your research" (Ravitch and Riggan, 2012), which allowed the research to focus on the meaning generated from the study.

3.6 Methods of data collection

The study used semi-structured interviews as means of obtaining information about the participant's attitudes, views and perception on the use of ICTs in the classroom and how ICTs can be implemented to enhance and elicit effective teaching and learning. Classroom observations were used as means of developing a realistic picture of what happens in real practice. Interviews with the participants were used to generate open- ended answer. This allowed the participants to highlight their strengths and weaknesses in implementing and using ICTs in class which contributed to effective teaching and learning within the subject Technology. The manner in which these were structured also allowed the participants the freedom to conduct their lessons freely and be open during interviews. Most of the participants were free and did not feel judged during classroom observations. During interviews, the participants noticed that I was adequately versed on the subject and its teaching practices. This lead to the participants providing me with information that reflected the truth in practice highlighting the effectiveness of teaching and learning when ICTs are integrated into the subject Technology classroom, especially in teaching of the concept of Mechanical Systems and Control and its Mini-PAT. Where I did not understand and suspected bias I reflected on the interviews as means highlighting the discrepancy of what was observed to the responses given during interviews. This led to the study collecting data that was balanced as the two tools used greatly influenced the study. The study is certain that the data that was collected is trustworthy in respect to the triangulation method used.

The structure of these allowed the researcher to draw on the responses and insight of the participants on the use of ICTs in practice thus provided the researcher with a picture of a suitable intervention programme that can address the interesting aspects that emerged from the interviews and classroom observation.

An interview as well an observation schedule was drawn up to afford the researcher to formulate a set of predetermined questions that will engage the participant to provide an insight to the problem posed. It should be noted that the names of the participating schools and the teachers teaching Technology in a Grade 8 class are pseudonyms and not the participants or the schools real names.

3.7 Population and sampling

In qualitative enquiry, choosing a study sample is important as it looks at the practicality and efficiency of studying a population. As Denzin (1989) says “all sampling activities are theoretically informed” (Denzin, 1989, cited in Marshall and Rossman, 2011, p.104). Therefore in using sampling, qualitative research aimed to identify information that is researchable and usable from its selected participants. Qualitative research also upholds that “data generation process involving activities that are intellectual, analytical and interpretive” (Marshall and Rossman, 2011, p.104).

3.7.1 Population

In identifying the population in the study, the study also took into consideration the size to be sampled and “the means of identifying individuals in the population” (Creswell 2003, p.156). The study participants were four Grade 8 Technology teachers, from two different ICT piloted township schools.

3.7.2 Sampling

In qualitative research, identifying “the sampling design for population” is important (Creswell 2003, p.156). The study made use of single staged sample as it allowed the researcher to have “access to names in the population and can sample the people (or elements) directly” (Creswell 2003, p.156). The study generated its data from participants who provided the research with rich information that assisted the researcher in addressing issues that were central to the purpose of the research.

Purposive sampling was used to select four secondary school teachers who teach Technology Grade 8 as means of drawing in rich information from the research participants'.

3.8 Purposeful sampling

The idea of sampling in research is "centred on the selection of people or things from wider populations" (Scot and Morison, 2006, p.221). It is seen as "a systematic way of choosing a group of small enough to study and large enough to be representative" (Shipman, 1988, p.52). Furthermore, it refers "to the activities involved in selecting a subset of persons or things from a larger population" (Scot and Morison, 2006, p.219). Sampling remains to be an important part of research as it feeds into the research to help researchers reach generalised conclusions about their study. Thus sampling is a means of control (Shipman, 1988, p.52).

The study made use of purposive sampling as to help the researcher to "make theoretically informed decisions about whom or what to include in their sample" (Scot and Morison, 2006, p.221). The participants in this study were chosen on the basis of the subject and Grade that they were teaching and on the premises that they were knowledgeable and informative concerning the research phenomena that the researcher was investigating.

3.9 Data collection

The study followed a qualitative research approach. The study focused on a sample of two Secondary ICT 'piloted' schools in Tembisa, North of Johannesburg. Data was collected through classroom observation and semi- structured interviews with teachers of the subject Technology during different topics covered under the concept of Mechanical system and control and its Mini PAT lesson.

Purposive sampling was used to select four secondary school teachers who teach Technology Grade 8 who provided insight that assisted the research to develop a better understanding of the research problem. The participants of the study were

purposively chosen based on the subject they teach and Grade (Grade 8 technology teachers).

3.9.1 Classroom Observation

Observation of the teacher in practice using ICTs in their lessons, served to establish and confirm teachers' ability to use ICTs and its tools to aid the learning and teaching process. Furthermore, the research highlighted the effectiveness of teaching and learning when ICTs were integrated into the classroom. The research foregrounded the challenges that teachers have in using ICTs in their lessons to indicate how ICTs are used and their impact in learning in real classroom practice. The following statements were in response to classroom observation: The teacher uses ICTs to teach Mechanical systems and control, teachers ability to communicate design ideas using ICTs during the teaching of Mechanical systems and control, the teachers ability to anticipate, plan and explore the possibilities of the problem or needs that might arise when using ICTs in Mini PAT, The ways ICTs are integrated in the teaching of Mechanical systems and control, The quality of TPACK that is evident in the teaching of Mechanical systems and control Mini PAT, the strategies that the teacher uses to enable effective teaching and learning using ICTs, the teachers ability to plan the look of the product using ICTs and the significance of ICTs in the preparation of a Mini PAT. (See Appendix L)

3.9.2 Semi-structured Interviews

Semi-structured interviews are seen a type of interview in which the interviewer asks predetermined questions. Qualitative or semi-structured interviewing has its own character, and despite some quite large variations in style and tradition (Mason, 2002, p.62) and these are its features:

1. The interactional exchange of dialogue. Qualitative interviews may involve one-to-one interactions, larger group interviews or focus groups, and may take place face to face, or over the telephone or the Internet, for example.

2. A relatively informal style, for example, with the appearance in face-to-face interviewing of a conversation or discussion rather than a formal question and answer format. Burgess's term 'conversations with a purpose' captures this rather well (1984: 102).
3. A thematic, topic-centred, biographical or narrative approach, for example, where the researcher has a number of topics, themes or issues which they wish to cover, or a set of starting points for discussion, or specific 'stories' which they wish the interviewee to tell. The researcher is unlikely to have a complete and sequenced script of questions, and most qualitative interviews are designed to have a fluid and flexible structure, and to allow researcher and interviewee(s) to develop unexpected themes.
4. Most qualitative research operates from the perspective that knowledge is situated and contextual, and therefore the job of the interview is to ensure that the relevant contexts are brought into focus so that situated knowledge can be produced. For some that extends into the assumption that data and knowledge are constructed through dialogic (and other) interaction during the interview. Most would agree that knowledge is at the very least reconstructed, rather than facts simply being reported, in interview settings.

According to this perspective, meanings and understandings are created in an interaction, which is effectively a co-production, involving researcher and interviewees (Mason, 2002, p.62). Qualitative interviewing therefore tends to be seen as involving the construction or reconstruction of knowledge more than the excavation of it (Mason, 2002, p.62).

The interviews held in study focused on several issues; including the interviewee's views about the use of ICTs in class, how ICTs elicit, aids or hinders teaching and learning within the subject; and training, skills and knowledge that the teachers must have in order to be able to use and integrate ICTs in the classroom. The researcher recorded and transcribed data from the interviews and observation. I used validity in a fairly straightforward, common-sense way to refer to "the correctness or credibility of a description, conclusion, explanation, or other sort of account" (Maxwell, 2010). Thus, the two methods presented above served to reduce any subjective bias by

conducting the study in two schools instead of one school. In so doing, the findings widened the researcher's perspective on the study topic.

3.10 Credibility of the study: validity and reliability

Reliability and validity play an important role in research as they depict the credibility and trustworthiness of the study. Reliability and validity in research can therefore be seen as what demonstrates the communicativeness and trustworthiness of the research and its findings.

3.10.1 Reliability

Traditionally, reliability is used as a measure of quality… the key to successfully applying a notion of reliability is that the object being measured remains stable (Scott & Morrison, 2006, p.208). Since reliability concerns itself with finding out whether the research can be replicated for further research using qualitative instruments, it puts pressure on the researcher to ensure that their study remains reliable because in qualitative research, "a measure is reliable if it provides the same results on two or more separate occasions, when the assumption is made that the object being measured has not change" to truly say that a study is reliable.

Inter-ratter or inter-observer reliability was used to measure reliability in the study. Inter-ratter or inter-observer reliability is used to test the degree of convergence or divergence between their different observations (Scott & Morrison, 2006, p.208 and 209).

3.10.2 Validity

Validity in research concerns itself with questioning the accuracy of the research findings and how they were obtained. This in turn questions the research tool and the measures that were taken in coming up with the research findings. Cuba and Lincoln (1985) suggest the following to be the criteria for determining validity:

- "credibility (whether respondents agreed that the researcher had adequately represented their constructions of reality);

- transferability (whether the readers of the research agreed that the conclusions reached related usefully to settings which they themselves were immersed in);
- dependability (whether the researcher had been able to identify his/her effects during fieldwork and discount them);
- confirmability ('the key question here is whether the data are qualitatively confirmable; in other words, whether the analysis is grounded in the data and whether inferences based on the data are logical and of high utility" (Cuba and Lincoln 1985: 323)

The study made use of the research tool (interviews and classroom observations) as means of ensuring the validity of the study.

3.11 Ethical considerations

Permission was granted by the schools principals and the Department of Education to conduct the study at the selected schools. A letter of approval with a protocol number from the University of the Witwatersrand School of Education Ethics Committee was sent to GDE and I was approved to conduct my reach in schools. The Gauteng Department of Education sent a letter of approval approving my application to conduct research in schools. I introduced myself as a student of the Witwatersrand who would like to conduct research at their school. The selected schools were informed about the study through letters requesting permission for their partaking in the study. Upon receiving the letter of approval from the schools, consent forms stating the details of the study were given to four teachers; two teachers from different schools requesting permission of an interview and to classroom observations. Participants were informed that their participation in the study will be voluntary and that should they experience any discomfort during the research they can freely withdraw from the study.

3.12 CONCLUSION

This chapter presented the research design that was adopted by the study as means of answering the research question. It also outlined the presented the conventions of research concerning methodology. The qualitative research paradigm and research methods along with interviews and observation as methods of data collections were discussed in detail as mean of outlining the problems faced by the research. In this chapter I highlighted the withdrawal of one of the participants in the study. Their withdrawal had a slight impact on the study but nonetheless I am happy that the information gathered from the other research participants was fruitful enough to give this research structure and meaning. I am very much thankful for the input provided by the other research participant. Finally the chapter illustrated how it maintained the participants consent and confidentiality. Chapter 4 present the analysis and interpretation of data.

Chapter 4 Findings of the study

4.1 Introduction

The previous chapter focused on research design and the methods that were used in the gathering and analysis of data for this study. This chapter provided an analysis and interpretation of data that was collected by means of classroom observation and through semi-structured interviews as means of collaborating teachers' views which were the main data collection tools that were used per school. The data was collected and analysed in an attempt to provide answers to the problem outlined in chapter 1 of this research report. The chapter provides answers related to the main research question of the study which is: What difficulties do teachers have in implementing ICTs in the teaching of a mini PAT in Mechanical System and control concept in a Grade 8 Technology class? The latter, being the central question "is a statement of the question being examined in the study in its most general form" (Creswell, 2003, p105). From the literature that was reviewed in the study and through the collection of data; the researcher was able to develop an understanding of the competencies needed to be developed by teachers in the incorporating and implementation of ICTs in their classrooms. The latter further shaped and influenced the teaching and learning practices that took place in the classroom thus making the researcher to identify the challenges that also arise when teachers incorporated and implemented ICTs into the classroom.

The chapter presented data that was collected per school from the data collection tools used in each school. Prior to presenting the data that emerged from responses of the study participants, a brief description and information of the school and its participants was provided. Furthermore themes that emerged from data collections from the four study participants through the use of classroom observation and interviews were presented. This all contributed to the researchers' ability to be able to report accurately the findings and their relevance to the study.

4.2 Site selection

According to Marshall and Rossman (2011) the researcher makes selection of sites and samples of times, places, people, and things to study. This then makes the

research site and its participants to be important elements in any research. The research site and participants in this study were selected using purposeful sampling. The research site that ware selected for this study was two township high schools that are part of the 'piloted schools' for paperless classrooms within the East Rand and four Grade 8 Technology teachers. As previously mentioned the two schools are part of the 'piloted schools' for paperless classrooms, these schools mirror or rather envisage schools of the future in the township. Teachers of these schools are using various ICT tools as means of teaching and learning as required by the MEC and Department of Education. Permission to conduct the study was sought from the principal of the two schools.

4.3 Information about the participants and the schools

Participants play an important role in any research as they shape and inform the researchers study by providing them with information that is relevant for the study. This segment presents a brief description of the research participants and the schools. It is worth noting that all of the participants that participated in this study were not qualified to teach the subject but had experience teaching within the senior phase. They had adequate information relating to the study as they were all trained and inducted to teach within the phase. The latter was highlighted by the researcher when presenting information about the participants and their teaching background and experience. The information that was presented in the study does not reveal the true identities of the participants and the schools as means of maintaining and respecting participants' confidentiality and protecting the reputations of the participants and their schools. The participants, in alias (pseudonyms) were Ms Rakgotso and Ms Mokwena of Phathimfundo Secondary School and Mrs Masombuka and Mr Dwili of Thuto ke Lefa Secondary School.

4.3.1 About the participant

The participants' ages of this study ranged from 34 to 54 years. The participants were initially three female teachers and one male teacher from two different schools.

Unfortunately one of the female teachers from one of the schools withdrew from the study.

Ms Rakgotso, aged 41, is a qualified teacher with a B.Ed. degree specialising in the Senior and Further Education and Training (FET) phase and qualified to teach English and Technology which she has been teaching since 2008. She obtained her first degree from Makhado College of Education in Limpopo where she specialised in Maths and Biology (three year course) and later studied Technology at the University of Johannesburg (two year course). She currently occupies a post level one position.

Ms Mokwena, aged 46, is a qualified General Education and Training (GET) teacher within the Intermediate and senior phase and Further education and Training phase, specialising in Technology (Food nutrition, Housing and Clothing, Consumer and Education) and Consumer Studies in which she obtained from The University of Zululand. She has been teaching for more than 20 years and currently occupies a Head of Department (H.O.D) position in the school.

Mr Dwili, aged 34, is a qualified B.Ed. teacher specialising in Technology, Social Science and Geography which he obtained from the University Of Fort Hare, Eastern Cape. He has four years of teaching experience and currently occupies a post level one position.

Mrs Masombuka, aged 54, is a qualified General Education and Training (GET) teacher within the Intermediate and Senior phase and Further education and Training phase, specialising in Mathematics and Technology. She has a Bachelor of Arts (BA) and B.Ed. degree in which she obtained from a university in Gauteng. Participant did not want to disclose the name of the university. She has been teaching Mathematics for 28 years, 10 to 12 years Mathematical Literacy and 4 years Technology and she currently occupies an H.O.D position.

All the participants that took part in the study were qualified High school teachers with teaching experience ranging from four years to twenty eight years in practice. The input the participants gave in this chapter influenced and shaped the research methodology of the study, research design, data collection procedures, the population as well as the sampling procedures that were employed in the study. The participants' views and opinions that were presented, reflected their experience and

views on teaching with ICTs and was appropriate for the study as it provided the researcher with insight and knowledge that mirrored what was happening in practice. This is the information that the researcher would not have acquired if it was not for the help of the participants and thus made their input and views appropriate and relevant for the study. Ms Mokwena is the research participant that withdrew from the study because she felt uncomfortable and thought that the study would expose her and her teachings. Her input and views, although enriching and eye-opening were not used in this study as the participants relinquished the rights for the researcher to do so when she pulled out of the study. All the participants were observed while they were teaching the subject Technology and Mini PAT, during Grade 8 lesson. The participants' lessons fell under the same topic- Mechanical Systems and Controls but different aspects of the topic were observed and covered as per guidelines by the Annual Teaching Plan (ATP). Lesson plans and teaching material were not requested from the participants, as the study focused on teachers effectively integrated ICTs in their lessons. The researcher and the study was concerned by the manner in which teachers taught Mini PAT and the challenges that emerged from them using ICTs in their lessons.

4.3.2 Observations findings

The researcher has come to appreciate that "observation is a fundamental and highly important method" that forms part in all qualitative inquiry (Marshal and Rossman, 2011, p.140). Observations highlight detailed and specific information about educational activities and practice that would be difficult to ascertain in other circumstances… [thus it enables] researchers to sample educational experience first-hand rather than depend on what participants say they do (Scott and Morrison, 2006, p.168). In this segment I present findings based on classroom observation. The observations of the lesson were based on teachers' availability and timetable and were followed by post-observation interview. This allowed the researcher to discuss the researches aims based on the lessons observed. The data that was collected served to achieve three things. Firstly, to understand how ICTs were integrated by teachers in a Technology classroom. Secondly, to understand strategies teachers employed in their teaching that aided the effectiveness of

teaching using ICTs in the subject, lastly, to understand how ICTs could be of significance in the delivery of the concept of Mechanical system and control and Mini PAT. The following manifestations of TPCK were used to analyse data across the study participants.

This enabled the researcher not only to develop a holistic picture and understanding of what happens in classrooms but understand first-hand challenges faced by teachers' and their experience when integrating and using ICTs in their lessons. The latter enabled the researcher to develop an understanding of how effective teaching and learning is achieved in practice using ICTs in the subject Technology classroom, especially in teaching of the concept of Mechanical Systems and Control and its Mini-PAT. In so doing the researcher was concerned at looking at and understanding the teachers effectively taught thus highlight their capabilities as well as the challenges that they face when integrating ICTs into their lesson whilst utilising the facilities that they have at their disposal. Secondly, the researcher adopted and maintained a triangulation approach using responses that were received from the research participants, which later allowed the researcher to compare and categorise the responses from the teachers in a thematically form (generating themes from their responses).

Observation with the research participants lasted for five days, within a period of three weeks, across the two different schools and depending on the teachers' timetable. The observation focused on the teachers' ability to teach effectively using ICTs. Teachers were required to be able to operate ICT tools in their lessons especially in the teaching of the concepts of Mechanical Systems and Control and its Mini PAT; In this case all the schools in this study used smartboards, tablets and laptops as means of delivering their lessons. This study's observation aimed to highlight the elements of TPACK that teachers mastered in their teachings. The study chooses to focus TK, TCK and TPK as they were seen important in addressing the research problem. The study found that the teacher's ability to use different representation helped enhance their teaching and engaged learners even more in the learning process.

4.3.2.1 Technology knowledge (TK)

During classroom observations, I found that not all teachers that participated in the study were qualified to teach the subject. This was mainly because at the time most of the teachers assumed the role of being Technology teachers, the subject was relatively new. All the teachers in the study had received ICT training as the schools were pilot schools, thus it was a requirement that all teachers be trained in using ICTs in the school and in their lessons. All the teachers that participated in the study seemed open and confident in using ICTs in their lessons. Due to fiscal and geographical factors, such as distance and teachers urgency to meet ATPs and syllabus completion time, I was only able to observe one lesson from each teacher focusing on different topics of Mechanical systems and control. One lesson lasted 60 minutes while the others were 30 minutes each. The difference in duration of the lessons observed was due to teachers' time table of each school and when they were able to teach a specific content under the topic of Mechanical systems and control and its Mini PAT. Teachers in this study had received training and had people from the department of education offer specialised one-on-one training during schools and after school hours. Teachers were also expected to use ICT centres closest to them as means of developing further their technology skills. After receiving numerous training teachers were able to adapt to their new environment and make changes relating to technology. This allowed them to develop an understanding of working with technology and its various tools as means of achieving effeteness in their teachings and recognising when technology can promote educational achievement or hinder it.

4.3.2.2 Technological Content knowledge (TCK)

Teachers that were observed in the study displayed similar practices as they all had smartboards (two smartboards per classed displayed side-by-side) in their classrooms. A lesson that was memorable from the others was by Mrs Masombuka, she taught the concept of gear ratios and Min PAT. The lesson was 60 minutes long (double period). The teacher began her lesson by drawing on the previous concept learners had covered and then introduced the lesson. On the first half, the she projected PowerPoint slides, from the teachers' laptop to the smartboard, with

activities and notes for learners to take down. The teacher probed learners with questions as to how they were to calculate mechanical advantage. Learners were grouped in groups of 8 and were able to brainstorm and come up with solutions to the problem posed. Learners had to apply knowledge of calculating ratios from previous lesson to solve the tasks they were given. They wrote the answer on the smartboard for others to take down. I observed that learners were intrigued and participated more when smartboards were used. The teacher was able to navigate smoothly across the smartboard and its features. The teaching and learning practices that were observed were admirable compared to the conventional method of teaching. The teacher saved the work done by the learners on the smartboard to be accessed and revised for her next lesson. Using the blackboard the teacher would have to start over parts that they had erased whereas with the smartboard the teacher open her files to access the work she had already done.

On the second half, learners continued to work on their Mini PAT project as the teacher provided learners with cudboard boxes, glue and scissors. The teacher showed learners a replica of the Mini PAT project she wanted learners to make. No ICTs were used as learners were using their technical skills to design and create the Mini PAT. On his lesson on Mini PAT, Mr Dwili had displayed PowerPoint presentation slides using his laptop to the smartboard. He had displayed a replica of the Mini PAT project for the learners to design using 3D animation as means of calculating gear ratio. He also had projected Word document in which learners used to answer the activities they were provided by the teachers. The teachers that were observed understood that using a specific technology can change the teaching and learning practices. They understood the importance of matching the appropriate technology in helping learners understand concepts in a specific content area. Thus tin most of their lessons were able to teach effectively.

4.3.3.3 Technological pedagogical knowledge (TPK)

> *Integrating technology is not about technology – it is primarily about content and effective instructional practices. Technology involves the tools with which we deliver content and implement practices in better ways. Its focus must be on curriculum and learning. Integration is defined not by the amount or type of*

technology used, but by how and why it is used. (Earle, 2002, p. 8 cited in Niess et al, 2009, p.7)

The above quotation highlights the complexities involved in teaching with technology and stresses that having technology in the classroom does not guarantee that successful teaching and learning has taken place. Therefore, teachers and their competencies are the driving forces to the success and failure of technology integration.

As previously mentioned, teachers in this study had adequate skills and competency in integrating and using ICTs in their lessons. Teachers were able to link appropriate technology to content as means of enhancing teaching and learning. Teacher knew when and when not to use ICTs in their lessons. Mrs Masobuka's lesson highlighted a balance between ICT use and teachers pedagogical and use of instruction, and tried to homogenise teachers' traditional instructional practices to the medium that had used in their lesson. Teachers were enthusiastic and showed passion when delivering lessons. Ms Mokwena revised a lesson on levers and asked learners to list the different classes of levers and provide scenarios as to when each class could be applied in real life. The teachers approach was interesting as it allowed learners to make links of what was learned in class and relate it to the real word. She had projected PowerPoint slides relating to the different types of levers. She demonstrated how learners are exposed to different types of levers by sweeping the floor thus introducing another topic, mechanical advantage, which they were also revising. Learners freely engaged in the lesson and were happy to participate as they were interested in writing in the board. This boasted the teachers confident to use the smartboard as learners would assist the teacher which changing slides when the teacher was walking around the classroom. The teachers' scaffolding skills and use of practical examples helped learners to understand better the concept of levers, linkages and mechanical advantage. In teaching the concept of levers, linkage and mechanical advantage, the teacher had to tap into their own understanding of the concept (influencing content), selecting the appropriate tools and material to be represent the content (influencing technological knowledge) and selecting the

methods that were going to be used to deliver the lesson (influencing pedagogy). These manifested in the manner in which the teacher delivered their lesson.

Tablets, laptops and smartboards were dominant ICTs used across the lessons observed. Teachers' and learners were connected to the schools Wireless (WI-FI) and were able to use the internet to search for information to expand what they had learned. Observations in this study allowed the researcher to develop skills that could be implemented to improve teachers' abilities to use ICTs in practice.

During observation, the study attempted to highlight the worldwide consensus about the benefits of ICTs in the education system. What was discovered is that they have the potential to improve teaching and learning practises and enhance teaching and learning standards, if used appropriately. Hennessy, Harrison and Wamakote (2010) support the latter by further adding that there is substantial evidence that, in the right hands and used appropriately for specific purposes in specific contexts, ICT can be an effective tool in supporting teaching and learning. Teaching is a very complex and crucial process that helps learners acquire knowledge; it therefore becomes important the person responsible in imparting and transmitting knowledge to others is knowledgeable and competent in their subject matter. In order to be able to use and effectively utilise these ICT tools in schools, teachers need to have developed the necessary skills and knowledge to help them successfully integrate ICTs in their teaching. Hence ICT training is empirical for teachers. It is worth mentioning that the role of technology in schools is not to be perceived as a remedy to all the educational problems, rather it should be seen or perceived as a means of attempting to address these problems. Teachers were observed incorporating different technologies to enhance a particular pedagogical approach. This then enabled teachers to represents digital tools in multimodal presentational manner in their lessons.

4.3.3 Interview findings

Like observations, interviews form an important part of qualitative enquiry. Interviews being personal in nature have the ability to enable the researcher to obtain detailed information about the participants as means of exploring in depth research problems.

The researcher chose to use semi-structured interviews as means of encouraging the “interviewees to respond open-endedly and 'to answer a question in his or her own terms” (ibid cited in Scott and Morrison, 2006, p.133). According to Marshall and Rosseman (2011) qualitative researchers rely quite extensively on in-depth interviewing. In qualitative enquiry, interviews as well as other methods that are used to collect data are used to help the researcher to develop a deeper understanding of social phenomena. Kvale (1996) describes qualitative interviews as “a construction site of knowledge” (p.2), where two (or more) individuals discuss a “theme of mutual interest” (Kvale & Brinkmann, 2009, (p.2) cited in Marshall and Rosseman, 2011, p.142). The researcher gets to understand the research participants by exploring their views and opinions and this enables the researcher to get a better grasp of what teachers face on daily basis in practice through the use of open ended questions. The research is able to understand what happens in real-life practices so as to develop in-depth understanding of what happens in practice thus this informs the manner in which data was collected.

The interviews were respectively conducted amongst three teachers because one of the teachers withdrew from the study. Two of the teachers that were interviewed occupied an HOD post and one of the teachers occupied a post level one (1) position. The questions that were asked during the interview with the teachers aimed at reflecting how effective teaching and learning was achieved using ICTs in the subject Technology classroom, especially in teaching of the concept of Mechanical Systems and Control and its Mini-PAT. The latter foregrounded; teachers’ competency of ICTs and manner in which they were integrated in the classroom, teachers’ pedagogical practices or methods that informed their practice as well as the teachers’ content knowledge of the subject. Gradually the responses that were received from the participants’ differed immensely based on experience and the teachers habitus and beliefs about ICT integration in the classroom and lesson. However some of the responses were similar as teachers faced the same challenges

and gaps in integrating ICTs in their lessons and issues that arise within the subject itself.

Effective teaching and learning is depended on the teachers' mastery and competency in or of the subject that they teach. The study provided an in-depth discussion drawing from the literature reviewed in chapter (two) 2 reflected that there was an agreement amongst researchers that using ICTs in class is not the same as teaching with technology nor does it guarantee effective teaching and learning. The research concurred with teachers who stated that Technology was reasonably a new subject when they were introduced and inducted to teach it. Teachers were neither trained nor qualified to teach the subject but were expected to teach it nonetheless. All the teachers that were interviewed in this study were not qualified to teach the subject but have over the years developed the necessary skills and knowledge to teach the subject, making them experienced rather than qualified to teach the subject.

The researcher held and conducted separate interviews with the teachers that participated in the study. The study maintained a triangulation method as means of comparing responses received from teachers' as means of identifying patterns that emerged that were similar to help the researcher to generate themes. Furthermore, the interviews responses are presented in a discursive manner rather than responding to each teachers' response in relation to the questions posed. In addressing the first question, teachers were asked to describe their roles as Technology teachers, Mr Soga replied:

Is to make sure that learners are able to do things practical, are able to solve the problems, they understand the concepts in Technology.

Furthermore Ms Rakgotso highlighted:

To introduce technology into learners and make sure that they understand the meaning of technology and the importance of technology and they need to work practically based on their understanding of technology…

This question was posed to help the researcher understand the role of a technology teacher. The researcher came to understand that the teacher can be seen as a developer of creative and innovative thinking, a motivator to the future generation of

artisans, engineers, electricians to name but a few. The researcher articulated from the teachers that the role of a technology teacher is as follows:

- guiding learners in doing Technology tasks
- assessing learners using smartboards and tablets
- imparting knowledge of the practical parts

In addressing the second question, teachers were asked to comment on what they thought was the importance of teaching a learning subject Technology and what they did to enhance learning of Mini PAT in the subject. The responses that teachers gave ranged from them highlighting it being a practical subject and the importance of technological inventions that learners' come up with which derive from them implementing the subject into real life. Mrs Masombuka's response highlighted this as she divulged that Technology is "*practical and allows learners to be creative and gives learners the chance to be entrepreneurs in years to come so that they can use their abilities that they have learned at school*". The teachers' response exemplifies the importance of the subject thus demonstrating that the subject is not confined to the classroom only but that it is also applicable in real life situations.

I concur with the teachers' responses as technology, not just as a subject, but technology in general has become a very important aspect of our lives, as it gives knowledge and enhances our skills when it comes to developing learners minds about the world, industry etc. The subject then becomes important to both the teachers and learners as it looks at and focuses on real life situations and real life gadgets. The researcher came to understand that the teachers in this study try to show their learners how important it is for us to use technology. In the practical aspect of the subject the teachers try to show learners the importance of the subject by enhancing their lessons and using ICTs by showing learners videos related to the topic taught. Teachers also make their own models of Mini PATs from scratch to show learners that it's possible to make something on your own using technology.

In addressing the third question, teachers were asked to reflect on the level of quality of Technological Pedagogical Knowledge (TPK) that they needed to have in order to

integrate and implement ICTs in the teaching of a Mini PAT that involves Mechanical Systems and Control. All the teachers that participated in this study revealed that they did not have training nor were they qualified to teach the subject therefore they battled with answering the question. However, Ms Masombukas' response provided the researcher with a better insight of the knowledge that was required by a technology teacher because she has taught the subject the longest. She stated that:

In our case [as non-technology teachers], I think the biggest challenge is making drawings on the smartboard. It's a challenge, we are lucky to have educators who are qualified [educators who are qualified to teach the subject but are not teaching it because of the current posts that they are filling in the school]; educators who have good skills, and then in ICT; and they are the ones who are helping us on the way… because there are different pages that we use in order to draw. There is one that is 2D drawings and then there is one that is 3D drawings. Both need special pages or templates to do the drawings. Without that, learners won't understand what we are doing. But through the use of other teachers who are better qualified, or who have access, or more knowledge on ICTs then we are able to do it in class practically.

I could not help but be critical of the practices that are taking place in our schools; having teachers that are not qualified to teach the subject to teach it and those qualified to teach the subject to be assigned to other subjects. This is what is still driving our schools poor performance. I cannot help but question the credibility of knowledge that is transmitted by these teachers to our learners. I am reminded by Shulman and Bernstein who, in the educational field are regarded as regulators of knowledge. Bernstein was concerned with the "consequences that the production and transmission of knowledge had for different social groups" and "how this knowledge is related to structurally determined power relations" as well as how schools reproduce what they are ideologically committed to eradicating – social disadvantages in schooling and society" (Sadovnik, 1991:52 - 53). Educational knowledge is a major regulator of the structure of experience (Bernstein, 1971), this knowledge is what helps teachers to develop the necessary skills and knowledge that they need to master and teach a particular subject. Furthermore, formal education manifests itself through three message systems: curriculum, pedagogy

and evaluation. “Curriculum defines what counts as valid knowledge, pedagogy defines what counts as valid transmission of knowledge, and evaluation defines what counts as valid realization of this knowledge on the part of the taught” (Bernstein, 1971). It was evident from the participants that this was not the case. Nonetheless, the teachers in this study were resourceful enough to use the skills and knowledge from their subject majors and implement it into the subject to ensure effective teaching and learning.

As educators we are trained not to focus on one source of information, as the prescribed textbooks that we receive from the Department of Education tends to have limited information. Research is required and we use the prescribed books so that learners can also see what, how and where all the information is coming from. Also drawing from the ATP, teachers are able to take all the content knowledge and find ways to make it stimulating for learners. It becomes empirical for the teacher to master the Technological content knowledge of Mechanical Systems and Control, in order to be able to deliver and explain the Mini PAT well to learners.

In addressing the fourth question, teachers were asked to comment on the learners’ attitude towards the concept of Mechanical Systems and Control and or in Mini PAT. Teachers gave varying answers as this required the teacher to show an understanding of their learners’ attitude towards the use of ICTs in class when learning the concept of Mechanical Systems and Control and its Mini PAT. What I have come to understand and what I picked up from the teachers is that; our learners are not accustomed the culture of reading and writing. Thinking back when I did the subject at school, I used to hate making projects because I had the mentality and perception that I can't "make" these projects, I can't draw therefore that killed my creativity; and that was the case with most of these learners. But some learners look forward to next projects as they believe they can build better models than they did last term or last year, thus they give themselves a challenges. It then becomes different to learn and create Mini PAT using ICTs. In response to the question, teachers highlighted that learners actually liked and enjoyed learning the concept and doing Mini PAT when ICTs were involved. One of the teachers even said “*I think their attitude is positive, because they are coping, they are able to do what they are told to do. They are able to do practical tasks to solve the problem and I think they like it*”. This was interesting because it showed the potential ICTs brought into

practice. From some learners that were observed, it was evident that even without ICTs the response received was likely to be similar. The interest displayed by the learners who had similar attitude and perceptions as mine towards the subject was also interesting as they displayed a degree of interest when ICTs were involved. Learners are as curious as teachers if not more when ICTs are implemented in practice.

In addressing the fifth question, teachers were asked to address what they thought teachers' need to have when using ICTs in the classroom when teaching the concept of Mechanical systems and control. Aside from experience and having qualifications, a response that umbrella the whole questions and highlighting aspects of TPACK came from Mrs Rakgotso. She responded by saying:

"*Well the teacher must be familiar with the use of smartboard itself to start with, and again be familiar with the smartboard and in the smartboard…*". Mr Dwili further expanded by saying that; "*the experience that teachers needs is the practical work, to show the learners how to do things practically and also able to operate the smartboard to explain the concept on the smartboard*". Technological knowledge (TK) is strongly present and is seen as the essential requirement by the teachers when responding to this question. This is understandable as TK is often associated with having "Fluency of Information Technology (FITness)" according to the National Research Council (NRC, 1999). They argue that FITness goes beyond traditional notions of computer literacy to require that persons understand information technology broadly enough to apply it productively at work and in their everyday lives, to recognize when information technology can assist or impede the achievement of a goal, and to continually adapt to changes in information technology (NRC, 1999 cited in Niess, Ronau, Shafer, Driskell, Ozgun-Koca, & Kersaint, 2009). This goes to show that teachers need to familiarize themselves with recent technologies and update the information they have through workshop training and doing extensive research to broaden their subjects content knowledge. The latter will enable the teacher to accomplish a variety of different tasks using ICTs as means of developing different ways of accomplishing a given task. This conceptualization of TK does not posit an "end state," but rather sees it develop mentally, as evolving over a lifetime of generative, open-ended interaction with technology.

Questions 6 and 7 were answered collectively as they share similar qualities even though they are different in nature. Teachers were asked to comment on how they conceptualised and implemented ICTs their lessons and how they integrate ICTs in their Technology lessons. I felt that the responses received from teacher were vague and alluded that as long as teachers knew and have mastered TK, then they would be able to teach the subject. Luckily for me, these questions were answered during classroom observations. Loosely put ICT integration is about having the “appropriate selection, use, mix, fusion and integration of many sets of competencies including, but not exclusively, those in pedagogy and technology" (Information and Communication Technology in Education, UNESCO; 2003 cited in the Department of education, 2007, p.4). Teachers are required to be able to use and integrate ICTs in their lessons using different repertoires in order to be able to cater for and address the needs of their subjects.

First and foremost, it is important to acknowledge that “There is no “one best way” to integrate technology into curriculum” (Koehler & Mishra, 2009, p.62). However teachers can be trained and guided into finding ways to integrate ICTs in their lesson, in a manner caters and fits into their lessons. Koehler & Mishra (2009) recommend that an approach is needed that treats teaching as an interaction between what teachers know and how they apply what they know in the unique circumstances or contexts within their classrooms. Teachers in this study collectively said that they contextualise and implement technology by making use of gadgets around them in order to make learners understand the world around them. This also meant that teachers had to teach using their laptops and project power point presentations and videos that showed learners step by step how to do the Mini PAT.

It is very much clear to say that there is no one best way to integrate technology into curriculum or any subject as there are no guidelines available yet as to how to do so. I agree with Koehler & Mishra (2009) who believe that, “integration efforts should be creatively designed or structured for particular subject matter ideas in specific classroom context… we propose that understanding approaches to successful technology integration requires educators to develop new ways of comprehending and accommodating this complexity”. Koehler & Mishra (2009) further propose that [developing] understanding approaches to successful technology integration requires educators to develop new ways of comprehending and accommodating this

complexity. Having such multiplicities of ICT integration can be quite overwhelming as ICTs don't provide solutions to teaching a subject as of yet. This puts more pressure on the teachers as they have to constantly find ways to improve their teachings by finding a balance between technology, content and pedagogy.

Questions 8 and 10 were discussed collectively as they address the importance of the subject and the opportunities that stimulated learning that teachers can use. In addressing the eighth and tenth question, teachers were asked to provide their perception on how they perceived ICTs and what they makes a Mini PAT about Mechanical Systems and Control as a concept challenging or special. Having to understand the complexities involved in using and integrating ICTs in class, it is important to understand that ICTs in schools is not just about using tablets and smartboards alone, there's broader ways in which ICTs can be used and the study will discuss this further as the discussion progresses.

What was evident in some of the technology classes was that the role ICTs played cut across more than merely the use of computers for teaching and learning. As such they are very significant in that they assist the teacher to be able to Design different drawings with regards to a particular topic and its' Mini PAT. They can assist in designing clear 2D and 3D designs, exploded views, etc. ICTs can also assist the teacher with creating different types of Mechanical advantage calculations. The teacher can also create a Flow Chart template for the learners to fill in as they do their Mini PAT. This helps regulate what the learner does and avoid unnecessary steps in the chart. They are also able to go online as such further research becomes possible helping the teacher to think outside of the box rather than sticking to work in the text book or the ATP. The teacher is also able to get updated and receive more recent valid prices of materials and labour costs. This segment also caters for question 6.

Teachers in this study at some level try different means of getting learners interested in the subject by creating and having different stimulants for the learners. Teachers engage learners in the lesson. For example, teachers allow learners to discuss applying for a tender. They start off by believing that they are business men or women that are actually involved in the construction industry and as they discuss you realize that they want to win the tender more than other groups and they try

every possible way to make their presentation the best there can be for the Tender Board.

In addressing the ninth question, teachers were asked to highlighted gaps that they identified or that exist in integrating ICTs into a Technology subject. I found that even though teachers had received numerous training, they were not well versed with smartboards. Others existing gaps included un-availability of teaching and learning material and equipment like computers, interactive boards, Wi-Fi connectivity, adequately trained teachers on how to use the ICT equipment, a well-orchestrated syllabus that infuses the various subjects with ICT, cash flow for running costs, well equipped computer classrooms with air-conditioning, and proper security for the equipment. At the end of it all, it bores down to availability of a working budget in order to integrate ICTs into the Technology subject.

In addressing the last question, teachers were asked to comment on what they believe makes a Mini PAT about Mechanical Systems and Control a concept challenging or special. Teacher's responses to this question were similar in a sense that they alluded that the subject lacked material related to development and creation of Mini PAT, and that has a huge impact on the subject. Ms Rakgotso responded by saying that "*it becomes a bit challenging, when they could not like get the material cause at the school we also have a challenge of having resources cause. The leaners have to look for the materials on their own so it becomes a challenge because some of them are coming from poor back ground where they could not afford material on their own*". Mrs Masombuka added that "*sometimes the challenge is with us because some of the teachers are failing the subject. They drag their feet… especially the ones that who have the know-how of this practical thing. They were supposed to make a budget and but unfortunately they didn't so that you can use the TSM (Teacher Support Materials) budget to get the wires things and the need correct resources that is the only challenge"*.

There's a strong link between teachers habitus and beliefs and teachers ability to integrate ICTs in their classroom. There is a recognized relationship between competence and confidence of teachers in including ICT in their instructional practice and their level of training and opportunity to get training (Jones 2004 in Law et al cited in Howie 2010). Teachers competence, confidence, attitudes, believes and

perceptions impact the manner in which ICTs will be facilitated in class. If the teacher is unsure of how to operate the ICT tool, this may impact their usage of the tool in their lessons. The teachers that had partaken in the study displayed an adequate level in terms of operating the tools. Their perceptions and views were different in terms of classroom management and discipline, which affected the teacher's ability to deliver lessons using ICT tools. Overall, teachers' preferred having ICT tools in their classroom, as the tools were viewed to minimise time and which enables the teacher to cover content intended by the curriculum in the time required.

The teachers that participated in this study had all received training from the Department of Education and occasionally attend workshops to improve their ICT skills thus were all competent enough to use ICTs. I concur with Zhao and Cziko (2001), who argue that many teachers use technology, not because it helps them achieve a new goal, but because it allows them to achieve their current goals more effectively than do their traditional methods (Zhao and Cziko, 2001, cited in Ertmer, 2006, p.33).

4.4 Themes that emerged from observations and interviews

Given the complexity of teaching with ICTs, there has not been a one general or single method that the Department of Education has prescribed in the school policy or curriculum that tells teacher what to teach and how to teach it. This is why teachers need to have and develop a balance between knowledge of their areas of specialisation, pedagogy and knowledge of ICT integration into their lessons. In this day and age, teachers are expected to have developed an understanding of ICTs so as to be able to integrate it into their teachings.

The implementation of ICTs in schools enables a level of autonomy in which the teacher enacts, thus allowing the teacher to influence and shape the curriculum. On the other hand, "practice gets at the way individuals, and groups, engage in situated behaviours that are both constrained and enabled by existing structures, but which allows the person to exercise agency in the emerging situation" (Sutton & Levinson, 2001, cited in Vandeyar 2013). At the end of the day, the teachers are bound to adhere to the requirements of the curriculum set and shaped but the education

system. Therefore, the teacher's ability to influence the curriculum is minor, and serves to expand on concepts they feel restrict the information the learner is supposed to receive. The following themes emerged from the data that was generated from classroom observation and interviews with the teachers.

4.4.1 Classroom equipped with ICT tools

The schools that were observed had received infrastructural upgrades and one was a relatively new school. In each class two smartboards were displayed side by side. Teachers were given laptops and learners were given tablets and the schools had free wireless fidelity (WI-FI) that could be used by both teachers and learners and the community.

4.4.2 Competency to teach using ICT tools teach

According to UNESCO (2011) the ICT Competency Framework for Teachers is aimed at helping countries to develop comprehensive national teacher ICT competency policies and standards, and should be seen as an important component of an overall ICT in Education Master Plan. This meant training teachers to use ICTs. All the teachers that were observed in this study had received ICT training and thus were all competent to use ICTs in their lessons and teachings. Teachers develop competencies that allowed them to use ICTs within the following six areas; Creativity and Innovation; Communication and Collaboration; Research and Information Fluency; Critical Thinking, Problem Solving and Decision Making; Digital Citizenship; and Technology Operations and Concepts. Within each of these areas, the teacher is able to transfer the knowledge into the curriculum and content using technology. The teacher gets to collaborate with other teachers online and exchange information. This allows them to rethink traditional approaches when offering e-learning (ICT) based learning which allows learners to engage in the learning process as means of improving learning and driving their own learning.

4.4.3 ICT savviness

According to Mishra and Koehler (2008), teaching with technology is an overlap between subject matter content, technological knowledge, and pedagogical processes used by teachers in their endeavour to promote student learning (Mishra and Koehler, 2008, cited in Jaipal & Figg, 2010). TPACK is designed around the idea that content (what teachers teach) and pedagogy (how they teach it) must be the basis for any technology that the teacher plans to integrate and use in their classroom to enhance learning. Furthermore, TPACK is required for ensuring the efficiency of teaching and learning. The experiences that the teacher undergoes during the different processes or level of TPACK, enriches and strengthens the kinds of knowledge the teacher has. All of the teachers that participated in the study were ICT savvy. To reiterate, the teachers had undergone training and occasionally attended ICT workshops as means of improving their skills, provided by the Department of Education. TPACK highlights the manner in which teachers' development in using ICTs impacts the design of professional development and classroom practices.

4.4.4 ICT integration

ICT integration is about having the "appropriate selection, use, mix, fusion and integration of many sets of competencies including, but not exclusively, those in pedagogy and technology" (Information and Communication Technology in Education, UNESCO; 2003 cited in the DoE, 2007, p.4). Teachers are required to be able to use and integrate ICTs in their lessons using different repertoires and infuse it with their pedagogies. The teachers that participated in this study were all able to use and effectively integrate ICTs into their lessons. They were able to select relevant materials related to the topic of Mechanical Systems and Control Mini PAT and combine them with the appropriate ICT tools and resources to enrich and enhance their lessons.

4.4.5 Challenges in integrating ICTs

The challenges that emerged from the teacher using ICT were more on the technical aspect rather than the personal or professional aspect. The smartboard would take time to power on and some were not working and some took time to respond to the teachers' navigation and would go to different icons rather than the icons that the teacher had selected. Some of the smartboards were not even functioning. The technical team took time to repair the smartboards and the teacher had to alternate between the smartboard and the chalkboard.

4.5 CONCLUSION

Throughout the different chapters, the study has revealed the importance of research and why the researcher has embarked in the study. It should be clear in all the chapters the purpose and aims of the research were highlighted, discussed and presented. The researcher has also come to understand that across the different chapters, the purpose and aim of research was to inform action. This made it easier for the researcher to use different tools at their disposal as means of contextualising the study and its findings. This was done in a manner that pursued to ensure and maintains a standard that is of high quality, with the research enquiry as this impacted the information that was obtained as means of producing knowledge and information that is applicable and relevant for this study. The next chapter presents themes that emerged from empirical data, their analysis and discussion.

Chapter 5: Data analysis and discussion

5.1 Introduction

Across the different chapters that were discussed and presented in this study, it has become eminent and visible that ICTs do play a vital role in shaping and changing the nature of the education system; how teaching and learning occurs, the different affordance that comes with using and incorporating ICTs in practice. This then gives rise to a learning environment that shapes not only the nature and nurture of teaching and learning but influences the teaching and learning practices that exist thus shaping teachers and learners' attitude, values and beliefs.

This chapter provides an analysis and interpretation of the empirical data that was collected. The data used in this study, was carefully examined as means of maintaining validity, credibility and accuracy and then categorised into themes. The themes that emerged were analysed and interpreted in this study drawing from the methods of collecting data used from the previous chapter. The themes were categorised into two sections: firstly, those that reflected positive integration and implementation of ICTs in schools; secondly, those that represented negative implementation and integration of ICTs in schools. The data from this research was interpreted using an inductive approach which will be briefly expounded on below.

5.2 Data analysis and interpretation

The process of bringing order, structure, and interpretation to a mass of collected data is messy, ambiguous, time consuming, creative, and fascinating (Marshal and Rossman, 2011, p.206) and tends to frustrate researchers but it is something that has to be done. The process of data analysis involves making sense out of the text and image data (Creswell. 2003, p.190). Qualitative data analysis is a search for general statements about relationships and underlying themes: it explores and describes and builds grounded theory (Struass & Corbin, 1997 cited in Marshal and Rossman, 2011, p.206). The process of analysing and interpreting data is done by the researcher as means of building and highlighting the relationship and the manner in which information explains a phenomenon related to the study by focusing on the

how and why. The latter enables the researcher to draw new connection of knowledge from what is already known.

Qualitative data analysis “involves using open- ended data… this requires asking general questions and developing an analysis from the information supplied to the participants” (Creswell. 2003, p.190). Therefore, the process of analysis involves the researcher interpreting responses from the participants, drawing from the interview question using the inductive approach.

5.3 Research methods and findings and analysis

Having realised that our countries “education systems has an obligation to deliver on public expectations of quality education for economic growth and social development” (White paper, 2006, p.8). It is still saddening that most public schools within the township setting still face issues of overcrowding, some are still under resourced, have poor infrastructure and have limited teaching and learning resources to name a few. Nevertheless, Gauteng’s MEC, is confident that ICTs have the potential and capacity to overcome most of these barriers and has thus chosen a few of these schools to pilot as ‘schools of the future’. Since ICTs are still new in schools and are still being implemented, it becomes too early to criticise whether they really are the solution to the challenges faced by our education system currently or not.

The researcher has realised that it is imperative to maintain “the needed flexibility of design” (Marshal and Rossman, 2011, p.90). To reiterate, the data in this study was collected through the means of classroom observations and semi-structured interviews and these were collected from four Grade 8 Technology teachers from two different township schools.

5.4 General findings of the study

Observations in this study allowed the researcher to develop an understanding on how teachers use and integrate ICTs in their lessons on daily basis. During classroom observations, I found that the teachers that participated in the study were

not qualified to teach the subject because the subject was relatively new when they assumed the role to be technology teachers. However, all the teachers in the study had received ICT training as the schools were pilot schools thus it was a requirement that all teachers to be trained in using ICTs in school and in their lessons. All the teachers that participated in the study were open and confident in using ICTs in their lessons despite challenges that they encountered such as delayed response from the smartboard to name but a few.

The teachers in this study knew how to integrate ICTs into their lessons and were able to teach the subject very well, regardless of the fact that they were not really trained nor qualified to teach the subject. Aspect of TPACK that teachers flourished in was PCK, TK and TCK which was outlined in chapter 2.

5.5 Presenting findings and discussion

Noor-Ul-Amin (2013) distinguishes between ICTs for and ICTs in education, they claim that: “ICTs for education refers to the development of information and communications technology specifically for teaching/learning purposes, while the ICTs in education involves the adoption of general components of information and communication technologies in the teaching learning process”. This research explored the use of ICTs in education as means of developing and understanding how ICTs are used and integrated in practice. This segment presents the data that was obtained by means of classroom observation and semi-structured interviews with the teachers. Expounding from the previous chapter, the study will discuss collectively the findings from the observation and interviews thematically as means to avoid repetition and maintaining relevance in the study.

Factors that motivate the use of ICT in school

5.5.1 ICTs in Educational policy and curriculum context

I concur with Hennessy, Ruthven & Brindley (2005) who have identified that “there is a government drive towards provision of opportunities and expertise for using ICT in all schools, yet significant weaknesses are reported in policy and practice. The

present subject curricula, assessment frameworks, and policies concerning ICT use seem to simultaneously encourage and constrain teachers in using technology in the classroom". The policy regarding ICTs in schools has not been integrated into the school code of conduct or its policy thus teachers remain unclear on how integration and implementation happens. What other researchers have identified, is also what I have also identified in relation to ICT policy in schools and its integration, which is that; "national policymakers struggle, on the one hand, to create conditions that support these developments in their countries and, on the other, to craft policies and programs that cope with them and harness their effects to support economic growth and the public good" (Kozma, 2005, p.118). ICT policy needs to cater for the needs of that country and be made transparent in the schools policy. The one 'size fits all' notion does not work in addressing the needs of a country like South Africa in comparison to America. The conclusion was that "there is a government drive towards provision of opportunities and expertise for using ICT in all schools, yet significant weaknesses are reported in policy and practice… policy approaches which ignore personal and professional beliefs tend to construe educational technology as an innovation to be administered and then adopted by teachers"(Hennessy, Ruthven & Brindley, 2005). Therefore, "crafting the right public policy can be a huge challenge, particularly for a developing country" (Kozma, 2005, p.118). Kozma (2005) suggests that developing countries have to find the key pressure points and strategic levers within the system that can be used to initiate change and launch a virtuous cycle of sustained economic and social transformation.

It was observed during interviews with the teachers that policy regarding ICTs was not made transparent to teachers and stakeholders. That is why even its integration remains blurry. The schools in this study integrated ICTs into the classroom the best way they knew how; integration was also depended on teachers willingness, competencies and attitude. Thus the predominant mode of integration used by teachers was merely projection of notes and playing videos as means of enhancing learning. The assumption that ICTs tools and skills is what teachers can just pick up and use needs to be divorced.

5.5.2 Teaching the subject Technology

The study revealed that the subject encourages teachers to use ICTs in their teaching and lessons. Teachers' knowledge of teaching a subject "is significantly related to PK and PCK, but the amount of variance explained by this relationship is minimal" (Farrell & Hamed, 2017, p. 175). Furthermore, the subject practice – here, teachers' knowledge, understanding, skills, attitudes, goals, beliefs and pedagogy – thereby develops over time (Loveless et al. 2001 cited in Hennessy, Ruthven & Brindley (2005). The researchers are insinuating that teachers' qualifications within the subject do not really matter. Which matters is the amount of preparation put in by the teacher within the subject as means of creating and transmitting knowledge. The theoretical aspects of the subject enabled the teacher to factor into their lesson planning and preparation how they will use ICTs in their classroom. Teachers' qualifications and the fact that they were not qualified to teach the subject did not influence the teachers teaching or lesson delivery as teachers assumed the role as technology teachers and did the best they could to teach the subject. Therefore, in practice "numerous teachers instruct a subject for their entire careers that does not directly match their college education" (Farrell & Hamed, 2017, p. 175).

5.5.3 Years of teaching experience

Accepting to teach a subject that you did not receive training in, requires dedication and hard work on the teachers' part. The teachers' number of years in service served as a cornerstone for the teachers in this study. They were able to use their pedagogies drawing from the subjects that they are qualified to teach in, and integrate it into the Technology subject.

5.5.4 Teachers experiences in using ICT

Interview comment relating to teachers experience highlighted that teachers who are used to the conventional classroom (those who have been teaching the longest), needed more support in developing and mastering ICT tools as they possessed adequate technological skills. Nonetheless, these teachers were using ICTs in their

classroom and relied either on their colleagues or leaners to overcome barrier relating to ICTs.

5.5.5 Impact of subject cultures on using technology

One potentially important contextual factor which shapes how technology is perceived and used by teachers is the 'community of practice' (Lave and Wenger 1991) associated with their subject. Different subject department have different use for ICTs (Lave and Wenger, 1991 cited in Hennessy, Ruthven & Brindley, 2005, p.7). Each subject community could be said to share a set of tools and resources; approaches to teaching and learning; curriculum practices; cultural values, expectations and aims (Hennessy, Ruthven & Brindley, 2005, p.7). The research found that "subject cultures are an important influence in determining teachers' and students' use of ICT… There is also evidence that teachers choose ICT applications, activities and approaches to fit their own perspectives on teaching and learning (Niederhauser and Stoddart 2001 cited in Ruthven & Brindley, 2005). [Therefore], pedagogic perspectives vary both within and between subject disciplines, and will influence the evolution of subject practice" (Ruthven & Brindley, 2005, p.9) and the manner in which ICTs are used within the subject.

5.5.6 Producing a creative teaching and learning environment

Research found that the use of ICTs in the classroom "provides more creative solutions to different types of learning inquiries… Therefore, ICT involves purpose designed applications that provide innovative ways to meet a variety of learning needs" (Fu, 2013, p.113). In a practical subject like Technology, teachers are able to come up with stimulating methods that help learners learn better and get them interested in the design and creation aspect of the subject.

5.5.7 Improving the quality of teaching and learning

Further, Serhan (2009) concluded that ICT fosters autonomy by allowing educators to create their own material, thus providing more control over course content than is possible in a traditional classroom setting (Serhan, 2009 cited in Fu, 2013, p.114). Teachers in this study were able to use different resources such; as the internet, books and library, as means of sourcing out information related to the content and topics that were to be covered in class. Teachers creativity in relation to the subject and the manner in which they deliver lessons when ICTs were used had increased more compared to them using the blackboard and textbooks.

5.5.8 Teacher attitudes, perceptions, and confidence in ICT use

Teachers have the ability to create a learning environment that is engaging and meaningful, for both them and their learners. According to Zhao and Cziko (2001) three conditions are necessary for teachers to introduce ICT into their classrooms: teachers should believe in the effectiveness of technology, teachers should believe that the use of technology will not cause any disturbances, and finally teachers should believe that they have control over technology (Zhao and Cziko (2001 cited in Noor-Ul-Amin, 2013, p.6). These three conditions contribute to the effectiveness of integrating ICTs into the classroom. When teachers embed these conditions they are able to see the potential ICTs brings into the classroom thus enabling the teacher to develop autonomy in using ICTs. The study revealed that teachers shape the manner in which ICTs are integrated and implemented within their lessons.

5.5.9 Factors that constrain the use of ICT in schools

Factors which can act as barriers to using ICT include: lack of confidence, experience, motivation, and training; access to resources and timetabled use of dedicated ICT suites; unreliability of equipment; classroom practices which clash with the culture of student exploration, collaboration, debate and interactivity within which much technology-based activity is said to be situated (Hadley and Sheingold 1993, Schofield 1995, Becker 2000, Dawes 2001 cited in Ruthven & Brindley, 2005).

The research provides other containing factors that were observed during the collection of data within schools.

5.5.10 Tension between subject and ICT skills

Ruthven & Brindley (2005) have identified that the effect of these top-down policies has been a perception of eroded autonomy and a feeling of disempowerment in teachers. One notable factor affecting integration was the perceived conflict concerning whether to use ICT in order to facilitate subject learning, or whether the emphasis should be on demonstrating ways in which ICT can be used and teaching technical skills (Ruthven & Brindley, 2005, p.17). The research shares the same sentiments with the authors and feels that the two should not be viewed in isolation as they both display or rather highlight the impact ICTs haven practice. In looking at how ICTs are used to facilitate subject learning, the research noted that it is depended on the subject departments and hoe ICTs are used within that subject. In looking at demonstrating ways in which ICT can be used and teaching technical skills; the research found that teachers were the driving force to successful and failure of how ICTs are used in practice; Teacher habitus and willingness to use ICTs is a strong contributing factor in practice. In essence, successful ICT integration is depended on subject departments' use and in the teachers' willingness to use the tools. In the case of the schools that participated in the study, ICTs were well incorporated into the subject. Even though teachers were still reliant on textbook method, ICTs were used and utilised accordingly in these schools.

5.6 CONCLUSION

This chapter highlighted factors that constrain and motivate the use of ICTs in schools by teachers. Teachers perceptions, attitudes and views have changed from the first time ICTs were introduced in schools. The changes that were seen in this study and in practice were as follows: teachers no longer viewed ICTs as tools that sought to replace them thus have embraced them in their classrooms; the integration processes utilised by the Gauteng MEC has improved compared to the first ICT initiation programmes that were deemed unsuccessful namely Gauteng online

(which was always offline) and the Khanya project; and the teacher training and development programmes that are currently put in place by the department of education to better help teachers integrate and implement ICTs in the classroom, encourage teachers to use ICTs in their classrooms. Motivational factors regarding ICTs in schools outweighed constraining factors which indicates the changes in teacher perceptions regarding ICTs in the classroom. The themes that emerged during discussion highlighted a number of issues (due to the numerous themes that emerged, the research could only highlighted a few as means of strengthening teachers competency and effectives of using ICTs in the classroom. Both the schools that were selected as part of the study were part of the piloted 'schools for the future' initiative and the teachers within these schools highlighted the positive impact ICTs had in practice. The literature reviewed in chapter 2 revealed that in order for teachers to effectively integrate ICTs in their classrooms they needed to have the necessary skills and competence required in order to do so. The following chapter presents concluding remarks regarding the entire study. It recommends ways of improving ICT integration in schools and addresses challenges faced by teachers during integration. It also focuses on implications and recommendation that needs to be taken into consideration for further research purposes.

Chapter 6: Summary, limitations and recommendations

6.1 Introduction

The previous chapter provided an analysis and interpretation of the research findings. The data that was analysed and interpreted was collected from interviews and classroom observation. Four Technology Grade 8 teachers from two high school township schools, which are part of the pilot schools in Gauteng, were selected to be part of the study. The teachers were observed teaching the concept of Mechanical Systems and Control and then interviewed as means of triangulating data. The latter was done as means of achieving the following overarching aims of the study: To investigate the effectiveness of ICTs in the teaching of Mechanical System and Control concept in a Grade 8 Technology classroom and its Mini-PAT. The focus of this study was to observe the manner in which ICTs were integrated within the subject. The study also focused on teachers' skills, competencies and readiness in using and integrating ICTs into their lessons, to determine the effeteness of teaching with ICTs within the subject. This is in turn influenced by the teachers' attitudes and values towards using and integrating ICTs in the classroom.

6.2 Summary

This segment serves to summarise previous chapters by highlighting the research problem and issues that emerged and formed central points in each chapter. Drawing on from the research question formulated in chapters 1 and 2, the study has attempted to respond to the research questions in chapters 4 and 5. The main research question that was asked was "How is effective teaching and learning achieved when ICTs are integrated into a Grade 8 Technology subject, especially in teaching the concept of Mechanical Systems and Control and its Mini-PAT?". In order for the study to be able to respond to the main question the following sub-questions were explored and answered through the literature review, interviews and classroom observation:

- How are ICTs integrated in a technical Technology subject?
- What are the gaps that exist in integrating ICTs into the subject?

- How can ICTs be of significance in the preparation and delivery of a Mechanical system and control mini PAT?
- What strategies do teachers use to enable effective teaching and learning using ICTs in the subject?

This study responded to the research question asked in chapter 1. Chapter 1 revealed that the teaching and learning practices that take place in township schools are slowly improving and this is due to ICTs that have been integrated within schools. Successful and poor integration still manifest and is depended on the teacher's competencies in using and the ability to integrate ICTs into their lessons. However, there has been new literature and research concerning teacher training to enable teacher competencies, use and integration of ICTs in their lessons and teachings.

Chapter 2 reviewed the literature that informed the subject. In chapter 3 the study outlined the research design and methodology. Chapter 4 of the study revealed that teachers even though not qualified to teach the subject were integrating ICTs into their lessons and were competent enough to integrate and use ICTs in their lessons despite the challenges that they faced when integrating ICTs. The findings presented in chapter 5 revealed that teachers were competent but not qualified to teach the subject but were able to Integrate ICTs within the various levels of ICT integration using aspects of TPACK. Other issues that were identified in chapter 4 were extensively discussed in chapter 5. Chapter 6, being a concluding chapter, provided recommendation that can be considered by teachers and schools to improve ICT integration and implementation; and in the challenges that teacher face when integrating ICTs in their lessons. These could potentially lead finding strategies that could contribute to teachers' effectiveness and use of ICTs and integrate it into their classroom. The following solutions emerged from researchers looking into improving ICT integration, addressing challenges faced by teachers during integration and teacher competency that could potentially lead to the effectiveness of teaching with ICTs.

Being a concluding chapter, this chapter served to provide an overview of the whole study in general, and as previously mentioned, with the reference to the literature review, research questions and the analysis of data. The chapter has provided suggestions for further research, recommendations and limitations of the study.

6.3 Limitations of the study

Qualitative enquiry recognises that a study is subjected to experience or identify potential weakness of the study. The study has presented limitation of this study even though they are minute in nature, it is difficult for the study to make generalisations. A main limitation of this study was the limited literature surrounding the subject Technology. The research was informed by and centred on the Gauteng MECs initiative to turn township school classrooms into paperless classrooms, therefore the selected schools for this study were pilot schools and they were not in close proximity to the researcher and that resulted in fiscal constraints, time constraints and traveling distance. Another limitation was that out of the four participants that were selected to be part of the study, one withdrew from the study. The withdrawal of the participant narrowed the study even more. There is also a possibility that the remaining participants may have given responses that were subjective or generally acceptable rather than responses that reflect practice in reality. This was because the participants' responses and experiences in integrating ICTs within the Technology subject were at times similar. Therefore the views and opinions of the teachers that participated in study cannot be generalised to reflect the views and opinions of teachers from other township high schools. The study would have achieved findings that are enriching if it had a larger number of participants as this might have led to the researcher to procuring a variety of responses. Nonetheless, I have attempted to gather facts rather than opinions when conducting interviews and classroom observations as means of reducing subjective bias. I have employed the triangulation method as means of triangulating the different responses between participants as means of limiting bias. This was done to ensure that the study does not seem to be generalised as the researcher hopes that the findings from this study can in future be used or be applicable in other similar

studies and hopefully influence debates, results, trends and discussions around ICT integration within the subject.

In this study I made use of classroom observations and interviews as means of generating a holistic picture of how ICTs are integrated within a practical and technical subject Technology. This made the researcher to also focus on the teachers' skills and competencies which affected their use and integration of ICTs within the subject which is grounded on teachers' perceptions, attitudes, views and believes in the use of ICTs in their lessons. The latter helped the researcher to understand how effective teaching and learning was achieved by the participants of the study when they used ICTs in the lessons, especially in teaching the concept of Mechanical Systems and Control and its Mini-PAT. The researcher came to understand that there are forces (internal and external) at play that contribute to the success use or failure of achieving effective teaching and learning when using ICTs in education.

The main purpose of this research was to understand how effective teaching and learning could be achieved by teachers when they used ICTs in the subject Technology classroom, especially on in teaching the concepts of Mechanical Systems and Controls and its Mini- PAT. The study highlighted that literature surrounding the research is limited and hopes in future researchers can embark in strengthening the literature. Policy on ICT use in schools needs to be made transparent and explicit to teachers. The following segment will present the study conclusion and recommendations.

6.4 Recommendations

This study has adopted phenomenology as an approach which "seeks to explore, describe, and analyse meaning of individual lived experience: how they perceive it, feel about it, judge it, remember it, make sense of it, and talk about it with others"(Patton, 2002). The discussions provided in this study revealed that there's a lot that still needs to be done in schools in order to improve teaching and learning. The teachers in the two schools showed that they are dedicated to their work even though they are not qualified to teach the subject. Due to the resources and research

regarding the nature of the study being minute, the research revealed in literature review in chapter 2 that planning and preparation before lessons remains important, it advocates for further research. The study focused on highlighting how effective teaching and learning was achieved using ICTs in the subject Technology classroom, especially in teaching of the concept of Mechanical Systems and Control and its Mini-PAT.

The following solutions emerged from researchers looking into improving ICT integration, teacher development strategies to encourage effective teaching, addressing challenges faced by teachers during integration and teacher competency. They have recommended schools should:

- Provide professional development activities related to technology to update teachers' skills and knowledge, and offer technical support when needed (Al-Bataineh et al. 2008);
- Support partnerships that help teachers share effective technology practices and experiences (Ertmer and Otternbreit-Leftwich 2010);
- Provide workshops that allow teachers to reflect upon effective strategies for technology integration into instruction and unveil issues that are central to understanding the process of technology integration into instruction (Almekhlafi and Almeqdadi 2010);
- Offer opportunities to virtually observe teachers who use technology (Frederick, Schweizer and Lowe 2006);
- Augment curricula with technology-enhanced materials (Goktas, Yildirim and Yildirim 2009);
- Provide enough freedom for teachers in selecting and covering curriculum materials (Honan 2008);
- Provide effective, timely, and continuous training to improve ICT skills and manage a technology-rich classroom (Hutchison and Reinking 2011);
- Encourage positive attitudes about the significance of integrating ICT into instruction (Lim, 2007); and
- Provide adequate technical support (Liu and Szabo 2009; Tezci 2011a; Yildirim 2007).

The latter sought to bring about effective teaching and learning in any subject when ICTs are used in the classroom. Harris (2002) concludes that the benefits of ICT will be gained "…when confident teachers are willing to explore new opportunities for changing their classroom practices by using ICT. As a consequence, the use of ICT will not only enhance learning environments but also prepare next generation for future lives and careers (Wheeler, 2001). Changed pool of teachers will come changed responsibilities and skill sets for future teaching involving high levels of ICT and the need for more facilitative than didactic teaching roles (Littlejohn et al., 2002)… Such possibilities suggest changes in the communication models and the teaching and learning methods used by teachers, giving way to new scenarios which favour both individual and collaborative learning" (Harris cited in Noor-Ul-Amin, 2013, p.3). ICTs and teachers in this regard are viewed as catalyst for change in education.

Furthermore, Onwuagboke & Ukegbu (2010) provide the following recommendation as means of improving ICT integration in practice:

1) The government through the State Universal Basic Education Board should organize continuous and periodic training and retraining of teachers through capacity building workshops, seminars and conferences to boost their ICT literacy level to enable them utilize ICT resources while teaching their students.
2) There is an urgent need for government to provide ICT facilities at all levels of education.
3) There should be training of ICT experts specifically for instructional design who will work with the teachers and the students in the schools.
4) The problem of erratic power supply should be addressed while schools should on their own procure stand-by generators that can supplement the Power Holding Company of Nigeria (PHCN) for supply of electricity.
5) Every professional teacher should be computer literate and should not shy away from their teaching responsibility by dogging the use of ICT resources.

In so doing teachers will constantly develop skills to use ICTs and better their lessons. Teachers will also develop competencies that will allow them to use

technology in their classroom in different ways to suite learning and teaching outcomes.

Other recommendations included amongst others, included; matching the content uploaded onto the smartboard with the teachers' setwork, school's curriculum policy and textbooks, having a technical support team that is well trained and available at schools at all times, focusing on the teachers and the teacher training and not on the technology, organizing a small professional and decentralised management team, decentralising the technical assistance and training. Furthermore, the schools policy must be adjusted to fit ICT tools rules usage within a particular school and its classes, to enable teacher to use ICT tools available at their disposal and be able to manage their classrooms when integrating them. These are not solutions to the problem faced but recommendations.

6.5 CONCLUSION

This study has reached a conclusion and has noted that "teachers are the key persons to use of Information and Communications Technologies (ICT) in educational settings productively and to help integrate ICT into the curriculum" (Usun, 2009). This was supported by the literature which reviewed factors that motivated and constrained ICT integration in the schools and the classroom, these factors included; curriculum development in the education system, Technology as a learning area- focusing on the teaching of the concept Mechanical systems and Control and TPACK as a framework model looking at ICT integration. The literature utilised in this study made it apparent that ICTs are used in education as meditational tools that are not stagnant yet susceptible to change. The TPACK framework, which highlighted different frameworks that advocated for successful ICT integration, revealed that teachers and their competencies are the driving forces to successful and failure of ICT integration.

Effective use and integration of ICTs in our education systems entails teacher having to do more administration work in terms of lesson planning and they need to continue receiving training so that they are able to keep up with technological innovation so and their use. Participants of this study welcomed the use of ICTs in

their classrooms as it helped minimise teaching and learning time thus making teaching and learning to be more effective. A frequent challenge that teachers often face in using ICTs in the classroom is a technical malfunction from the smartboards. Aside from teachers only using smartboards in their class as a projection tools, ICTs do have the potential to make teaching and learning more effective. An upside in using ICTs in the classroom is that teachers do not have to worry about the shortage of textbooks. Even though there are factors that hinder effective use of ICTs (see chapter 5). Teachers highlighted that they often seek support from the ICTs technicians in the school in terms of using the smartboards and other ICT gadgets in their schools. They also seek help from teachers who are qualified to teach the subjects when they encounter changes within the subject. The effectiveness of using ICTs with the subject and in the classroom is sorely depended on the teacher. This chapter, which served as critical lens of the overall study highlighted and discussed the themes, limitation and possible solutions for future integration and implementation of ICTs in education.

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LIST OF APPENDICES

APPENDIX A: ETHICS CLEARANCE LETTER

Wits School of Education

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3221 • Fax: +27 11 717-3009 • E-mail: enquiries@educ.wits.ac.za • Website: www.wits.ac.za

Student Number: 691767

Protocol Number: 2018ECE023M

Dear Nobuhle Nkosi

Application for Ethics Clearance: Master of Education

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate, has considered your application for ethics clearance for your proposal entitled:

The effectiveness of integrating ICTs in the teaching of Mechanical systems and control in a Grade 8 Technology subject: A case of two township schools

The committee recently met and I am pleased to inform you that clearance was granted. Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely,

M Makgato

Wits School of Education
011 717-3416

cc Supervisor – Dr Samuel Khoza

APPENDIX B: GDE RESEARCH APPROVAL LETTER

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	10 September 2018
Validity of Research Approval:	05 February 2018 – 28 September 2018 2018/294
Name of Researcher:	Nkosi N.
Address of Researcher:	37 Mazibuko Street
	Thokoza
	1426
Telephone Number:	061 947 9621 073 100 8804
Email address:	nobuhle.nkosi6@gmail.com
Research Topic:	The effectiveness of integrating ICTs in the teaching of Mechanical Systems and control in a Grade 8 Technology subject: A case of two township schools
Type of qualification	Bachelor of Education Masters
Number and type of schools:	Two Secondary Schools
District/s/HO	Gauteng East

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

10/09/2018

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
4. *A letter / document that outline the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

.....

Mrs Faith Tshabalala
Acting Director: Education Research and Knowledge Management

DATE: 10/09/2018

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

APPENDIX C:

LETTER TO THE PRINCIPAL **DATE: 01 June 2018**

Dear Principal

My name is Nobuhle Nkosi. I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on '**The effectiveness of integrating ICTs in the teaching of Mechanical Systems and control in a Grade 8 Technology subject: A case of two township schools'**

I am asking for permission to observe and interview two Grade 8 Technology teachers to get a general understanding of how ICTs are implemented in the teaching of Mechanical systems and control concept in a Grade 8 Technology lesson that leads to the Practical Assessment Task (PAT) lessons. The reason why I have chosen your school is that it is one of the school that integrates ICT in the classroom. The school's reputation also played a role in my choice. My aim is to have two classroom observations with the Grade 8 Technology teacher and one interview session with them, preferably in the afternoon. I will also ask for learners' consent to come and sit with them as I will be observing their lessons and I will make it explicit in the letters directed to them that they are not going to be judged in how they will interact with the teaching process.

I would like to assure you that the research participants will not be advantaged or disadvantaged in any way. They will be reassured that they can withdraw their permission to participate in the study at any time during this project without any penalty. There are no foreseeable risks in participating in this study. The participants will not be paid for this study.

The names of the research participants and the identity of the schools will be kept confidential at all times and in all academic writing about the study. The schools privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,

SIGNATURE

NAME Nobuhle Nkosi

ADDRESS 37 Mazibuko Street

EMAIL nobuhle.nkosi6@gmail.com

TELEPHONE NUMBERS 061 947 9621

APPENDIX D

Principal's Consent Form

Please fill in and return the reply slip below indicating your willingness to allow me to conduct research in your school in a research project called: **The effectiveness of integrating ICTs in the teaching of Mechanical Systems and control in a Grade 8 Technology subject: A case of two township schools**

I, _____ give my consent for the following:

Permission to conduct research in your school	**Circle one**
I agree to be observed in class.	YES/NO

Permission to observe teachers

I would allow the researcher to observe teachers in the classroom for this study.

YES/NO

I know that I can stop the researcher at any time from coming to the school and if their observations are getting in the way of the teachers and learners learning.

YES/NO

Permission to interview the teachers

I would like the researcher to interviewed teachers for this study. YES/NO

I know that I can stop the researcher at any time from coming to the school and if their interviews take up teaching and learning time. YES/NO

Permission to audio tape

I will also request to audio tape the interviews in way of replaying the clips in order to capture all the information, as I will be writing the report. **YES/ NO**

Informed Consent

I understand that:

- My name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I can ask the researcher not to audiotaped, photographed and/or videotape

- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____ Date_____

APPENDIX E

LETTER TO THE TEACHER **DATE: 01 June 2018**

Dear Technology Grade 8 teacher

My name is Nobuhle Nkosi. I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on '**The effectiveness of integrating ICTs in the teaching of Mechanical Systems and control in a Grade 8 Technology subject: A case of two township schools**

I am asking a permission to observe and interview you to get a general understanding of how ICTs are implemented in your classroom. My research involves interviewing and observing you in a Technology Grade 8 class as a means of collecting data and getting a better understanding of the challenges and best practices that you use and are faced with in integrating ICTs in your class when you teach Mechanical systems and control. The reason why I have chosen your school is that your school is currently one of the few schools that are integrating ICT in their teaching and learning. The school's reputation also played a role in my choice.

My aim is to have two classroom observations of no more than 15 minutes each and thereafter will have face-to-face interviews during one afternoon that is of convenience to you. I will also request to audio tape the interviews in way of replaying the clips in order to capture all the information, as I will be writing the report. I will also ask for learners' consent to come and sit with them as I will be observing their teacher and I will make it explicit in the letters directed to them that

they are not going to be judged in how they will interact with the teaching process. I therefore request your permission to participate in this research so that you can help me identify any challenges or and best practices that you are faced with in your Grade 8 class when you teach Mechanical systems and control.

I would also like to mention that you will not be advantaged or disadvantaged in any way. You are therefore assured that you can withdraw your permission at any time during this project without any penalty. There are no foreseeable risks in participating in this study. Also, note that you will not be paid for this study.

Your name and the identity of the school will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,

SIGNATURE

NAME Nobuhle Nkosi

ADDRESS 37 Mazibuko Street

EMAIL nobuhle.nkosi6@gmail.com

TELEPHONE NUMBERS 061 947 9621

APPENDIX F

Teacher's Consent Form

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called: **The effectiveness of integrating ICTs in the teaching of Mechanical Systems and control in a Grade 8 Technology subject: A case of two township schools**

I, _____ give my consent for the following:

Permission to observe you in class	**Circle one**
I agree to be observed in class.	YES/NO

Permission to be interviewed

I would like to be interviewed for this study.	YES/NO
I know that I can stop the interview at any time and do not have to answer all the questions asked.	YES/NO

Permission to audio tape

I will also request to audio tape the interviews in way of replaying the clips in order to capture all the information as I will be writing the report. **YES/ NO**

Informed Consent

I understand that:

- My name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped, photographed and/or videotape
- All the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____ Date_____

APPENDIX G

INFORMATION SHEET PARENTS

DATE: 01 June 2018

Dear Parent

My name is Nobuhle Nkosi and I am a Masters student in the School of Education at the University of the Witwatersrand.

I am doing research on: **The effectiveness of integrating ICTs in the teaching of Mechanical Systems and control in a Grade 8 Technology subject: A case of two township schools**

My research involves observing and interviewing your child's teacher to get a general understanding of how ICTs are implemented in their classroom particularly during the Mechanical systems and control lesson. The reason why I have chosen your child's school is that the school is currently integrating ICT in its teaching and learning. The school's reputation also played a role in my choice. My aim is to have two classroom observations with your child present so that I can be able to observer how their teacher teachers and uses ICTs in their classroom. I therefore ask for your consent to allow me to observe a teacher teaching in your child's classroom. Your child is not part of the study nor will they influence it in any way. The letter seeks permission and your consent to allow me in your child's classroom so that I can be able to conduct my research as at the time I would be impinging on your child's

learning space. I want to assure you and them that I will not do anything to harm nor embarrass them during my presence.

Your child will not be advantaged or disadvantaged in any way. S/he will be reassured that s/he can withdraw her/his permission at any time during this project without any penalty. There are no foreseeable risks in participating and your child will not be paid for this study.

Your child's name and identity will be kept confidential at all times and in all academic writing about the study. His/her individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

SIGNATURE

NAME Nobuhle Nkosi

ADDRESS 37 Mazibuko Street

EMAIL nobuhle.nkosi6@gmail.com

TELEPHONE NUMBERS 061 947 962

APPENDIX H

Parent's Consent Form

Please fill in and return the reply slip below indicating your willingness to allow your child to participate in the research project called: **The effectiveness of integrating ICTs in the teaching of Mechanical Systems and control in a Grade 8 Technology subject: A case of two township schools**

I, _____ the parent of _____

Permission to observe my child in class	**Circle one**
I agree that my child may be observed in class.	YES/NO

Permission to be audiotaped

I agree that my child may be audiotaped during interview or observations.	YES/NO
I know that the audiotapes will be used for this project only	YES/NO

Informed Consent

I understand that:

- my child's name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- he/she does not have to answer every question and can withdraw from the study at any time.
- he/she can ask not to be audiotaped, photographed and/or videotape
- all the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____

Date_____

APPENDIX I

INFORMATION SHEET LEARNERS **DATE: 01 June 2018**

Dear Learner

My name is Nobuhle Nkosi and I am a Master student in the School of Education at the University of the Witwatersrand.

I am doing research on: **The effectiveness of integrating ICTs in the teaching of Mechanical Systems and control in a Grade 8 Technology subject: A case of two township schools**

My investigation involves exploring the role of ICTs in teaching and learning and their effectiveness in the teaching and learning of Mechanical systems and control in the Technology subject. I was wondering whether you would mind if I could sit in class with you and observing as I feel that I will be impinging on your learning space. I would like to assure you that my presence will not do anything to harm nor embarrass them you. I am trying to get a general understanding of how ICTs are implemented in classroom particularly during the Mechanical systems and control lesson and your teacher will be able to assist me with your help. The reason why I have chosen your school is that the school is currently integrating ICT in its teaching and learning. The school's reputation also played a role in my choice. My aim is to have two classroom observations with you present in class so that I can be able to observer how your teacher teachers and uses ICTs in their lessons. I therefore ask for your consent to allow me to observe them whilst they teach you. You will not part of the study nor will you influence it in any way.

Remember, this is not a test, it is not for marks and it is voluntary, which means that you don't have to do it. In addition, if you decide halfway through that you prefer to stop, this is completely your choice and will not affect you negatively in any way.

I will not be using your own name but I will make one up so no one can identify you. All information about you will be kept confidential in all my writing about the study. In addition, all collected information will be stored safely and destroyed between 3-5 years after I have completed my project.

Your parents have also been given an information sheet and consent form, but at the end of the day it is your decision to join us in the study.

I look forward to working with you!

Please feel free to contact me if you have any questions.

Thank you

SIGNATURE

NAME Nobuhle Nkosi

ADDRESS 37 Mazibuko Street

EMAIL nobuhle.nkosi6@gmail.com

TELEPHONE NUMBERS 061 947 9621

APPENDIX J

Learner's Consent Form **Date: 01 June 2018**

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called: '**The effectiveness of integrating ICTs in the teaching of Mechanical Systems and control in a Grade 8 Technology subject: A case of two township schools**

I, _____ give my consent for the following:

Permission to observe you in class **Circle one**

I agree to be observed in class. **YES/NO**

Informed Consent

I understand that:

- My name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped, photographed and/or videotape
- All the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____ Date_____

APPENDIX K

INTERVIEW SCHEDULE

1. Please describe your role as a Technology teacher
2. What is the importance of teaching a learning subject Technology? What do you do to enhance learning of Mini PAT in the subject
3. What quality of Technological Pedagogical Knowledge (TPK) do you need in the integration and implementation of ICTs in teaching of a Mini PAT that involves Mechanical Systems and Control?
4. How are the learners' attitude towards the concept Mechanical Systems and Control and Mini PAT?
5. What experiences do teachers need when using ICTs in the classroom when teaching Mechanical Systems and Control?
6. How do you as a teacher conceptualise and implement ICTs in your lessons?
7. How do you integrate ICTs in your Technology lesson?
8. How can ICTs be of significance to the preparation of Mechanical Systems and Control Mini PAT?
9. What are the gaps that exist in integrating ICTs into Technology subject?
10. Do you provide opportunities for simulated learning in the subject?
11. What makes a Mini PAT about Mechanical Systems and Control as a concept challenging or special?

APPENDIX L

TECHNOLOGY GRADE 8 OBSERVATION SCHEDULE

Item	**Remarks**
The teacher uses ICTs to teach Mechanical Systems and Control	
Teachers ability to communicate design ideas using ICTs during the teaching of Mechanical Systems and Control	
The teachers ability to anticipate, plan and explore the possibilities of the problem/ needs that might arise when using ICTs in Mini PAT	
The ways ICTs are integrated in the teaching of Mechanical Systems and Control	
The quality of TPACK that is evident in the teaching of Mechanical Systems and Control Mini PAT	
The strategies that the teacher uses to enable effective teaching and learning using ICTs	
The teachers ability to plan the look of the product using ICTs	
The significance of ICTs in the preparation of a Mini PAT	